INSECTS AND OTHER ARTHROPODS IN RELATION TO PUBLIC HEALTH IN ALBERTA.

by

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Signature of the author J.H.Brown....

PREFACE.

Most of the material in the following thesis is taken from the reports of the Alberta Rocky Mountain Spotted Fever and Sylvatic Plague Survey, of which the author is Officer-in-charge. This survey was initiated in the spring of 1938 following the compilation of information which indicated that plague, and certain tick-borne diseases that affect human health might be present in this province. The object of the survey was to determine whether these diseases were present, and if they were, to locate the infected areas.

The survey is supported by the Alberta Department of Public Health and the International Health Unit of the Rockefeller Foundation, and is operated by the Department of Public Health. The Dominion Department of Pensions and National Health assists in the work by examining all ticks, fleas, and tissue specimens for the presence of disease producing organisms. This examination is carried out at the Virological Laboratory, Kamloops, British Columbia, under the direction of Dr.R.J.Gibbons, Assistant Chief, Laboratory of Hygiene.

The work of the survey is divided into two parts:-

First:- The Rocky Mountain Spotted Fever Survey which operates from May 1st to July 1st, and consists of making collections of drag and host ticks which are examined at the Virological Laboratory for the spotted fever organism, Dermacentroxenus rickettsia Wolbach, and the tularaemia organism, Pasteurella tularense McCoy and Chapin.

Second:- The Sylvatic Plague Survey that operates from July 1st to September 1st, and consists of shooting and trapping ground-squirrels which are examined in the field for macroscopic plague lesions. Fleas and tissue specimens are collected from the ground-squirrels and are examined at the Virological Laboratory for the presence of the plague organism, Pasteurella pestis.

The author wishes to extend his thanks to the Alberta Department of Public Health, and to the Rockefeller Foundation for their kindness in allowing him the use of information gathered during the survey period 1938 to 1941 inclusive. Many thanks are due also to Professor E.H.Strickland (*), Head, and to Dr.R.W.Salt, Acting Head, Department of Entomology, University of Alberta, for their interest and assistance. Finally, the author wishes to express his most grateful thanks to Dr.M.R.Bow, Deputy Minister, Department of Public Health, Edmonton, for the kind interest shown and encouragement given during the entire period of the survey as well as during the preparation of this thesis.

John H.Brown.

(*) Now on War Services.

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PART 1.

TICKS AND TICK BORNE DISEASES IN ALBERTA.

TICKS AND TICK BORNE DISEASES IN ALBERTA.

ABSTRACT.

During the course of the four year investigation 43 localities were surveyed for the presence of ticks, and a total of 56,795 spotted fever ticks, Dermacentor andersoni Stiles, were collected. Two of the collections, one made at Manyberries and the other at Lethbridge were shown to be infected with the spotted fever organism, Dermacentroxenus rickettsi Wolbach, and twelve of the collections made at Milk River, Manyberries, Walsh and Whitla were found to be infected with Pasteurella tularense McCoy and Chapin, the tularaemia organism.

Eight cases of Rocky Mountain spotted fever, three of which were fatal, were found to have occurred in the Milk River, Manyberries, Calgary and Medicine Hat districts since 1935.

Two cases of tularaemia occurring in the Medicine Hat district were traced to tick bites, and two cases of tick paralysis in man were located in the Cypress Hills--Manyberries district. Two cases of tick paralysis in sheep were discovered in the Manyberries--Milk River district.

Considerable time was spent in evaluating tick population, and it was found that the rangeland is the most heavily infested area, with mixed farming and ranching lands second.

Many cases of infected tick bites were recorded as having occurred in the Manyberries area.

A type of paralysis that is suspected as being tick-borne was recorded from Eastend, Saskatchewan.

I. THE ROCKY MOUNTAIN SPOTTED FEVER TICK, DERMACENTOR ANDERSONI STILES.

Historical.

This tick was first described in 1905 by Stiles as Dermacentor andersoni. In 1908 it was again described by Banks #(2) as Dermacentor venustus, and he stated that " This species is quite common in the Northwest.-------- ----- This is the species supposed to be concerned in the transmission of spotted fever in Montana."

Banks' determination was accepted by all workers, and in the older literature the spotted fever tick is always referred to as Dermacentor venustus Banks. About 1925 it was discovered that Stiles' determination had priority, and in 1927 Stiles and Hassall (38) list the spotted fever tick as Dermacentor andersoni Stiles, and state that the name venustus must be considered dead.

Description.

The spotted fever tick, D.andersoni Stiles, is a member of the family Ixodidae, and is characterized by having a chitinized shield on the dorsum, and the head projecting in front of the body (Fig.1). The males and females can be distinguished by the fact that the chitinized shield covers the greater part of the male's dorsum, whereas in the female the shield is restricted to a small crescent-shaped area on the anterior part of the dorsum. In both sexes the shield

Numbers refer to the bibliography at the end of Part 1.

has greyish-white markings. The stigmal plate has a definite angulate prolongation (Fig.2).

The unfed adults are small,flat,brown and very hard. They cannot be crushed. On engorgement, however, the female increases in size and the body becomes very large and soft, and assumes a putty-color and a waxy-feel. The male, which only feeds slightly, never becomes engorged to the same extent as the female, and always retains the usual coloration and shape.

Importance.

The importance of this tick is very great for it is a known transmitter of Rocky Mountain spotted fever and Tularaemia, two very serious human diseases; and it is also the cause of Tick Paralysis in man, cattle and sheep.

This tick first assumed importance in 1903 when Wilson and Chowning advanced the theory that spotted fever was a tick-borne disease. This theory was proven in 1906 when Ricketts (33,34,35,36) succeeded in transmitting the disease from an infected to a healthy guinea-pig by means of a female tick. Later in the same year he showed that the male tick could also transmit the disease. At the same time King, who was experimenting with the possibility of tick transmission of the disease, was able to confirm Ricketts' work. Since that time Parker has definitely established that the only natural method of spotted fever infection is through the bite of an infected tick.

Fig. 1. Male spotted fever tick, Dermacentor andersoni Stiles.

Fig. 1. Female spotted fever tick, Dermacentor andersoni Stiles.

N.B. Above photographs after Cooley.

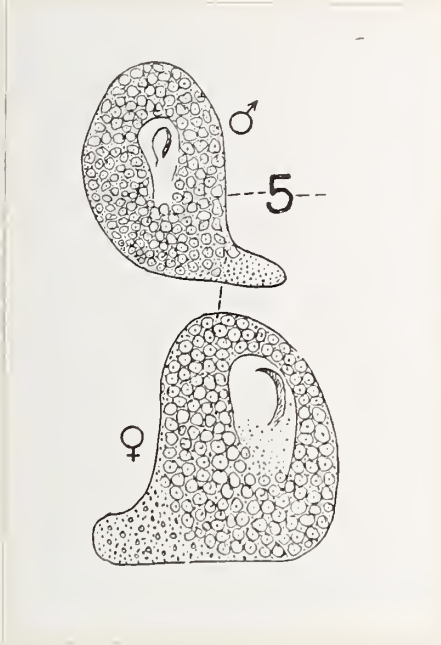


Fig. 2. Stigmal plates of male and female spotted fever ticks.

(Photograph after Banks.)

The first record of tularaemia-infected ticks was made in 1923 (Parker 30) when Pasteurella tularense, the causative organism, was recovered. Since that time it has been demonstrated that a very high percentage of ticks carry this infection.

Tick paralysis in man was noted by Todd (39,40) when he recorded the effect of tick bites on human beings in British Columbia. This work was substantiated by McCornack (19) who was working in the state of Washington.

Tick paralysis in sheep was recorded in 1913 by Hadwen (13) when he published his findings on the effect of tick bites on sheep. This was followed by Nuttall's (25) work in 1914.

Life History.

The life history of the spotted fever tick is very complicated, with four definite stages, egg,larva(seed),nymph and adult, and a life cycle of two or more years. It is a three-host tick with each active stage on engorgement dropping to the ground and moulting, and then transferring to another host-animal (37).

In Alberta the adult, which is abundant from April to August with the peak being reached during May (4), feeds in nature on such wild animals as coyotes, rabbits, deer and mountain goats, and on such domestic animals as horses, cattle and sheep. It feeds by inserting the mouthparts into the animal and drawing up blood, gradually increasing in size,

In the case of the female, until it is as large as the end of the little finger; in the case of the male there is very little increase in size. It takes about 12 days for the female to become completely engorged.

Copulation takes place on the host-animal and copulating ticks have been recovered from horses and range sheep in southern Alberta. Cooley (23) states that one male will often fertilize two or three females.

The female is fertilized during engorgement and as soon as engorgement is completed she drops to the ground and seeks a favourable place for egg-laying. This is usually under stones or around the crown of a grass plant, and here she lays between 2,000 and 8,000 eggs (23) usually in batches of 250. When the eggs are laid the female dies. The length of time required for egg-hatching depends on the temperature and varies between 17 and 51 days (23).

The eggs hatch into very small, six-legged creatures that are known as "seed" ticks or larvae. These seed ticks crawl up on vegetation and wait for some small rodent, such as a field-mouse or ground-squirrel, to pass within reach, and as the rodent brushes past they transfer to it. They work their way through the fur to the skin where they insert their mouthparts and feed for three to eight days. When engorged they fall to the ground and after a period of time moult into nymph ticks. These are of medium size and possess four pairs of legs.

The nymphs usually go into hibernation during the fall and winter, and come up in the spring, hungry and looking for

a host. They crawl up on vegetation and await the passing of some small animal such as a field-mouse, ground-squirrel or rabbit. When the animal brushes past they transfer to it and work through the fur to the skin----- usually around the neck or in some place where the animal cannot dislodge them ----- and attach and start feeding. In about a week or ten days the engorgement is completed and the nymphs drop to the ground and moult into adult ticks. These adults may find a host-animal, or they may remain in a quiescent state during the summer months, and then go into hibernation until the following spring. If the former case occurs then they will have completed the normal two-year cycle.

In the early spring, as soon as the snow melts, the adult ticks crawl up on vegetation and await the passing of a suitable host, but they now limit their choice to those animals from the size of a rabbit up, and will readily attach to man.

As both nymphs and adults will overwinter there are always two stages present in the spring, one a year behind the other in its life-cycle. ,Both nymph and adult ticks have been collected from the same rabbit in Alberta.

It is definitely known that the adults can, in the absence of suitable hosts, live for four years without feeding. That is, at the approach of hot, dry weather the adult ticks that have not had an opportunity to feed will go down to the ground and remain in seclusion until the following spring when they again crawl up on vegetation and await a host.

Failing to find a host they will repeat the period of waiting and come up the following spring. In some cases they have been known to repeat again the period of waiting and to come up for the fourth year.

This ability to survive for such long periods of time without feeding, coupled with the enormous number of eggs that are laid, is thought to be Nature's way of ensuring that the tick, which is so dependent on a succession of hosts, will have an opportunity to maintain its existence, for it is necessary for one pair of off-spring from one pair of parents to survive in order to keep the population normal.

Habits.

The adult spotted fever tick prefers animal hosts but it will readily attach to man, transferring from vegetation to the clothing. Being negatively geotropistic, it crawls upward, working its way amongst the clothing to the skin where it inserts its mouthparts and feeds by drawing blood.

The adult tick in waiting for a host hangs on vegetation with the head downward. It hangs on with all four pairs of legs until it senses the approach of a potential host-animal when it releases and waves in the air all of the legs except the third pair, ready to transfer to the host (5). This phenomenon was witnessed in Alberta in 1938 while ticks were being collected in the Chin Coulee. Here, on the sparse vegetation growing on erosion clay at the base of the cut-banks (Fig.3), ticks were observed in numbers, and considerable time was spent in studying the method of transference

to host-animals.

No reference has been found in literature regarding the diurnal and nocturnal activity of ticks, and the impression is conveyed that they are diurnal. During 1938 an attempt was made to find out if there was any nocturnal activity and the results obtained, although insufficient for drawing any definite conclusions, indicate that ticks are active at night. These conclusions were based on a comparision of a series of collections made during the mornings, afternoons and evenings of consecutive days. In theory ticks should be just as active during the night as during the day, probably more so, for it is at night that the native host-animals are the most active, and if ticks became inactive during the hours of darkness their chances of transferring to a host-animal would be very slight. There is also another factor that must be evaluated when considering the possibility of nocturnal activity, and that is the effect of temperature. Cooley (23) states that ticks become inactive at the onset of hot, dry weather, which implies that they are more active at low temperatures. It is well known that there is considerable drop in temperature at the beginning of night in Alberta and this condition might well produce increased activity on the part of the ticks.

Another ppint on which no information is available is the effect of weather on tick activity. Do ticks remain on vegetation during rain or snow storms, or do they seek shelter on the ground ? An attempt was made to answer this problem but due to the fact that the tick-drag became saturated,

and thereby useless, when dragged over the wet vegetation no definite conclusions could be reached. It was shown, however, that ticks could be taken during both rain and snow storms as long as the tick-drag remained dry. From this it would appear that ticks do not seek shelter during storms.

Tick Localities in Alberta.

Ticks have been collected in a great variety of surroundings in Alberta, ranging from the sage-brush and rose-bush filled coulees of the southeastern part of the Province to the timbered slopes of the Rocky Mountains. But in general typical Albertan tick country can be spotted at a glance. It is usually a small coulee or draw, well-covered with vegetation and possessing numerous cattle paths. It invariably has an eastern or north-eastern exposure, and the majority of ticks are usually found on the western and southern slopes. This is particularly noticeable in the Verdigris Coulee (Fig.4), an old river-bed east of the town of Milk River. Here ticks are exceedingly plentiful in the small draws on the west bank while similar draws on the east bank are devoid of ticks.

The choice of situation of adult ticks varies with different districts. In the sage-brush country of southeastern Alberta the best dragging places are cattle paths through brush-filled coulees, for these paths are used not only by cattle but also by the native animals, so that there is always a constant supply of host-animals for all active stages of the tick. Only on one ocassion have ticks been collected on the prairie proper, and these were taken on a small area in

Fig. 3. Chin Coulee at Foremost.

Fig. 4. Verdigris Coulee.

a sheep pasture.

In the Manyberries district where a very large number of ticks have been collected there are two main types of tick locality. The first type is found in the North Branch of the Manyberries Creek which is a shallow, wide coulee with alternating patches of grass and brush. A small stream winds through the coulee, and it is criss-crossed with the paths made by animals seeking water. Small wild animal life is abundant in the coulee. This area is of extreme importance because spotted fever infected ticks have been collected here, and four human cases of Rocky Mountain spotted fever, three of which were fatal, have occurred on the west bank of this creek (Fig.5). The second type occurs about seven miles southeast of Manyberries and consists of a long, narrow and deep coulee which is badly eroded on the bottom. There is considerable brush, but the cattle paths avoid it and are located about midway up the sides of the coulee. In this area the best dragging was on the grass along the paths, and it was here that the Albertan record was set when 2,100 ticks were collected by two men in six hours of dragging. A single drag of the cloth would often yield as high as 15 ticks.

In the South Branch of the Manyberries Creek (Fig.6) ticks are very scarce although the same type of vegetation is present.

In the Milk River district ticks are taken in the greatest numbers on small patches of short, green grass on the west slope of the Verdigris Coulee (Fig.7).

Fig. 5. North Branch of Manyberries Creek.

Fig. 6. South Branch of Manyberries Creek.

At Foremost (Fig.3) many ticks are taken on the sparse vegetation that grows in the hard, grey erosion clay along the bottom of the south bank of the Chin Coulee (18).

The greatest number of ticks ever taken in Alberta on a single drag was at Walsh in 1939 when 32 ticks were recovered. This drag was made on the short grass where a coyote path crossed a small draw on the west side of the Walsh flat.

Ticks are very plentiful in Medicine Hat area, and have been collected on the golf course and in small coulees in the residential section. In Lethbridge ticks have been collected on the east bank of the Old Man River within a few blocks of the centre of the city (Fig.8). One collection made 5 miles from the city in 1939 was found to contain spotted fever infected ticks.

It can be said that in southeastern and southern Alberta ticks will be found in any area where the distribution of hosts is such that the completion of the life-cycle is assured.

The Tick Infested Area in Alberta.

The known range of the spotted fever tick in Alberta (Map 1) is from the Montana border on the south to Township 33 on the north, and from the Saskatchewan border on the east to the British Columbia border on the west (4).

The area of greatest abundance is that part of southeastern Alberta (Map 1) that is bounded as follows:- On the south by the Montana border; on the east by the Saskatchewan border; on the north by the Canadian Pacific Railroad line

Fig. 7. Tick Collecting Area in Verdigris Coulee.

Fig. 8. Tick Collecting at Lethbridge.

from Medicine Hat to Bassano; and on the west by a line from Bassano through Macleod and Cardston to the Montana border (4). It is within this area that the majority of ticks have been collected, and it is here also that all of the spotted fever and tularaemia infected ticks have been found. All of the known and suspected cases of Rocky Mountain spotted fever, with the exception of two, have occurred within this area.

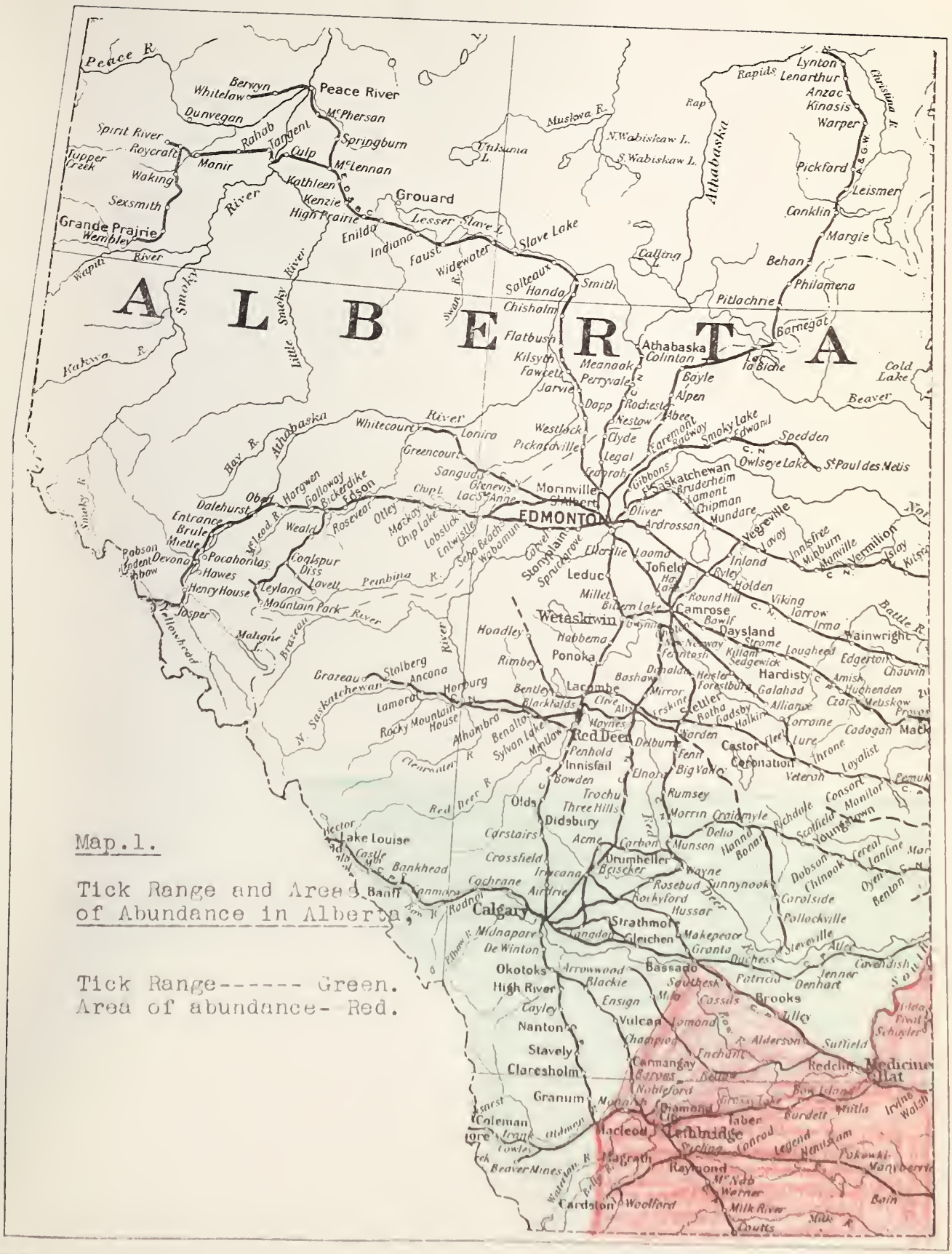
During the course of the investigation it soon became apparent that the density of tick population varied from area to area, but that there was a very definite correlation of tick numbers with the type of locality. This matter was investigated quite thoroughly and it was found that it was possible to map the areas of tick population (Map 2.).

A study of the map will show that the areas of greatest density are in the extreme southeast part of the province and along the rivers, and it will be observed that these same areas are the rangelands that support large numbers of cattle and sheep.

The areas of medium density are those in which much land is under cultivation, although large herds of cattle and flocks of sheep are also ranged.

The areas of light density are those in which grain farming is the main endeavour.

This distribution of tick population is as would be expected because in the rangeland there would be sufficient hosts for all stages of the life-cycle, while in the mixed farming area the smaller number of cattle and sheep and the intensive gopher control work would reduce the number of hosts.

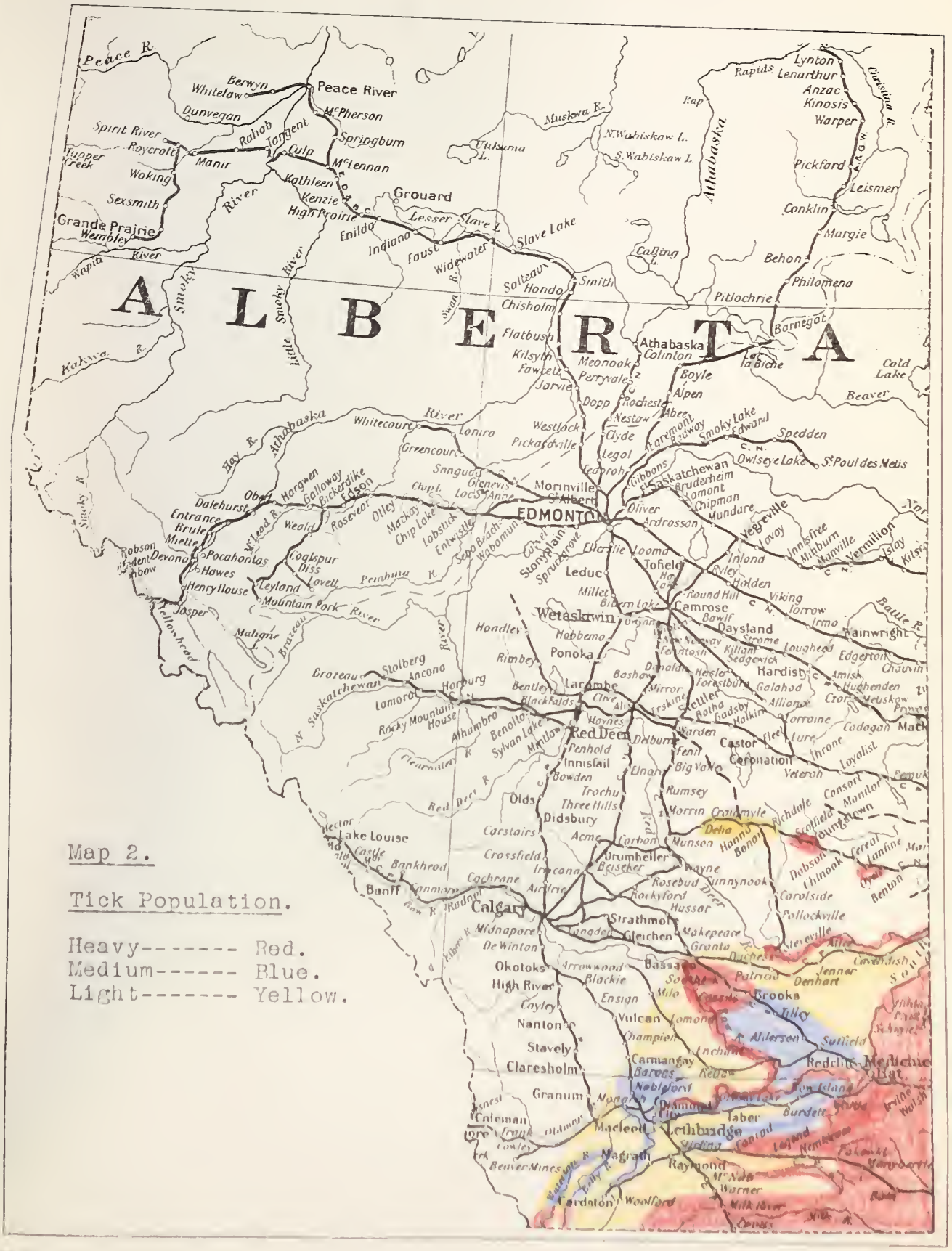


Map.1.

Tick Range and Areas of Abundance in Alberta.

Tick Range------ Green.
Area of abundance- Red.

FORM SE 33
4764-FSM-441



Map 2.

Tick Population.

Heavy------- Red.
Medium------ Blue.
Light------- Yellow.

In straight grain farming areas the number of hosts for all stages of the life-cycle would be at a minimum.

Probable Cause of Tick Abundance in Southeastern Alberta.

There has recently been much speculation regarding the abundance of ticks in southeastern Alberta, and many persons are of the opinion that the tick population has increased greatly in the past few years, while others are of the opinion that ticks have just lately moved into the country.

In an attempt to settle this problem interviews were had with early settlers and as much information as possible was gathered. The concensus of opinion amongst the early ranchers was that ticks were present when they arrived, but that there has been a very definite increase in tick population since 1900. Many of the old-time ranchers stated that the Indians were well acquainted with ticks and tick-country, and that they always warned the newcomers against building their shelters in the coulees. They also pointed out that during the summer the Indians always pitched their teepees on the prairie along the coulees, never in the coulee; but that in winter the teepees would be pitched in the coulees. This statement has been borne out by a study of the "teepee rings" (Fig.9), which are rings of stones for holding the bottom of the teepee down. In summer camps the teepee openings faced west, and in winter camps it faced east. These openings can be easily discerned as a definite break in the teepee ring. The position of the fire-hole is also another indication as it was always placed near the teepee entrance.

Fig. 9. Teepee Rings.
(Note tick-drag to left of ring).

Of the many teepee rings examined only those indicating a winter camp were found in the coulees.

There appears to be a great deal of supporting evidence for the assumption that the Indians pitched their teepees so as to avoid tick-infested ground, but not enough to exclude all other reasons, such as the desire to be in a position where they could not be surprised by their enemies as would be the case if their camps were in the coulees. However, the information gathered from the early settlers seems to indicate that ticks are native to this province, and that there has been a very definite increase in population since 1900.

The cause for this increase in tick numbers is not definitely known but three theories can be postulated. Two of these are quite involved and consider the effect of the importation of range cattle, both tick-infested and clean, on the native tick population. The third deals with the effect of prairie fires on the number of ticks.

Before these factors in relation to tick abundance can be considered it will have to be assumed that ticks are native to the country and that they were originally in a state of equilibrium with their hosts. There would, of course, be minor yearly fluctuations but in general the population would be stable.

A. Importation of Tick-infested Range Cattle.

It is well known that when the first settlers, the ranchers, moved in they brought with them large herds of range cattle. These cattle were trailed up from Montana, usually

during the spring and summer months (the tick months), and it can be safely assumed that they were infested with adult male and female ticks when they arrived in Alberta. These adults, being on a suitable host would feed and mate, and the engorged and fertilized female would drop to the ground and lay her eggs.

These eggs would hatch into seed-ticks and there would now be all of the "native" seed-ticks plus the "immigrant" seed-ticks with only the normal number of hosts. Each host is capable of supporting an almost unlimited number of seed-ticks; therefore the state of equilibrium is upset, for each host is now exposed to contact with the normal number of "native" seed-ticks plus a certain percentage of the "immigrants". There has been no increase in the number of hosts but each host now supports more seed-ticks, which means that more seed-ticks will be able to mature and moult into nymph ticks.

The same ratio of nymphs to hosts can be assumed, and at the end of the season there will be the usual number of "native" plus a number of "immigrant" adults going into hibernation.

The following spring the adults would emerge and await a host, but by now there has been a complete upsetting of equilibrium for not only are the "native" and "immigrant" adults supplied with more host-animals, but both native and imported host-animals(See Section B) are exposed to more adult ticks. This would mean that the adults would have more opportunities to feed, mate and reproduce.

The potential for an enormous increase in tick population is now coming into action, for each female above the normal number of "native" females that matures and lays her eggs affects the following generation, because she will have increased the number of seed-ticks and thereby caused more chances for the host-animal to come into contact with these seeds; this, in turn, would give more nymphs which would increase the chances of the nymph-hosts for coming into contact with them; the more nymphs that mature into adults will again give more chances for the adult-hosts to come into contact with the adults which will start the cycle off again.

The whole problem is further complicated by the continued importation of more range cattle and sheep which increases the numbers of adult tick host-animals.

B. Importation of Tick-free Range Cattle.

The importation of tick-free range cattle would increase the number of host-animals for the adult ticks which would mean that more adults would have an opportunity to feed, mate and reproduce. This, in turn, would produce an increased number of seed-ticks and enlarge the chances of their host-animal to come into contact with them. The more seed-ticks that matured would increase the number of nymph ticks. This would mean that there would be more adult ticks with more host-animals available. The cycle for increase would now start, but it would not be very rapid because there is only one outside factor--- the imported cattle-- that bears on the cycle.

C. Effect of Prairie Fires on Tick Population.

No reference can be found in literature on the effect of prairie fires on tick population, but it is obvious that there must be some definite relation.

It is well known that periodically in the early days, huge fires would sweep across the prairies destroying everything in their path and being stopped only by propitious rains, or by some large river that barred their way. It is also well known that these fires were most apt to occur during the spring and early summer, usually in May. Descriptions of the speed and heat of these fires leave no doubt but that many animals perished in their flames.

The fact that these fires occurred in May, which is the month when all stages of the tick are most plentiful, indicates that enormous numbers of ticks were burned to death, and that most of those that survived would be deprived of their host-animals, either by the animals being destroyed by the fire or by their being compelled to move farther afield in search of food. Such an occurrence would have a disastrous effect on the tick population, and it would take many years for the ticks to again achieve normality.

Probable Methods of Tick Control.

At present no effective tick control has been devised. This is due in part to the complicated life history of the tick, and in part to the abundance of tick hosts. In Montana the problem of tick control was investigated by Parker, Cooley and others, and they devised a method of rodent ex-

termination and domestic animal dipping with the view of reducing the tick population. This method was put into force but it was found to be impracticable on a large scale and had to be abandoned. It was shown, however, that good results could be obtained in small areas where complete co-operation of the livestock men could be had.

It is doubtful if any large scale experiments on the effect of burning tick-infested vegetation have ever been undertaken, but it would appear that this should be a very effective control measure. A few isolated references to the value of fire have all pointed out that the damage to the trees and shrubs was greater then the value of the control. In such a place as Manyberries Creek, where the only vegetation is buck-brush and rose-bush and of no value, fire may give a very good control.

The Alberta Method of Collecting Ticks.

The method of collecting in Alberta is essentially the same as that carried on in Montana, and consists of making collections of ticks in various areas.

In Alberta all ticks are considered as being positive for both Rocky Mountain spotted fever and Tularaemia, and consequently protective measures are carried out during the collecting. The first measure is the vaccinating with Rocky Mountain spotted fever serum of all persons employed on tick work. The second is the wearing of proper clothing during the collecting (See Section on prophylaxis). The third is the removal of the working clothes, the thorough examination

of the body, and the taking of a bath at the end of each day's work. The fourth is the immediate medical examination of any member of the collecting staff who complains of feeling unwell.

A. The Method of Collecting Drag Ticks.

All of the ticks (*) collected by dragging are unengorged adult males and females. That is, they are those ticks that have not obtained a host, but are on the vegetation waiting for an opportunity to transfer to some host-animal.

In the collecting, a"tick-drag" is used; this drag is a yard square of flannel cloth, preferably a cloth with a long nap, attached to a 5-foot pole (Fig.6). This drag is pulled over the vegetation with a to-and-fro motion, and the adult ticks transfer to it. The ticks are then picked from the cloth with the thumb and forefinger and placed in 2-inch shell vials stoppered with cork. One hundred ticks are put into each vial. All drag-ticks collected in the one area are given the same serial number.

(*) Two partially engorged ticks were collected on drags in the Manyberries area. It is believed that these ticks dropped from some host-animal that had died.

B. The Method of Collecting Host Ticks.

The collecting of host-ticks is a little more difficult as all stages of the active cycle can be recovered from hosts. In collecting feeding adults from horses (*), cattle and sheep the ticks are picked off with the thumb and forefinger and placed in 2-inch shell vials, between 50 and 100 ticks

depending on the state of engorgement, are placed in each vial. In collecting feeding adults and nymphs from jack-rabbits rubber gloves are worn and the ticks are removed with the aid of forceps.

All of the ticks collected from the one host are given the same serial number.

(*) During 1941 a total of 750 host-ticks were removed from an aged mare in the Seven Persons Coulee.

The Recording of Tick Collections.

Report cards are used for recording both drag and host tick collections. These are of two types, the Rocky Mountain Spotted Fever Investigations, and the Rocky Mountain Spotted Fever Daily Report (Fig.10).

On the investigations card there is space for all of the information pertaining to the location, type of area, date, weather, number of ticks taken, hosts, etc, and the signature of the collector. There is also space for the recording of laboratory information. An investigations card is made out for each collection that is made.

The daily report card is so arranged that it summarizes the number of ticks, both drag and host, that have been collected during the day. This card is not quite complete as it should have a space for the drag-tick serial number.

The method of recording the various tick collections has undergone considerable modification since 1938. In that year the collections were recorded as "A-1, A-2,etc", with the"A" indicating Alberta, and the number referring to the collection number. In 1939 this method was abandoned and

Spec. No..... R.M.S.F. INVESTIGATIONS ALBERTA

Location..... Date.....

Type of Area .....

Weather..... Collection.....

Host..... Shot..... Trapped ..... (A..... D.....) Drag.....

Number of Ticks	LARVAE	NYMPHS	ADULTS

Remarks .....

..... Inspector.....

(For Laboratory Use)	LARVAE	NYMPHS	ADULTS
Species; 1.....	.....	.....	.....
2.....	.....	.....	.....

Date Rec..... Condition..... Storage.....

Condition after Storage.....

Number and Date Tested.....

Epid. 12 5C-4-40 Report.....

R. M. S. F. SURVEY DAILY REPORT ALBERTA

Date..... Inspector.....

Type of Animal	S	T	F.D.	Host Ticks Sent to Lab.			Drag Ticks	Total Ticks	Other Parasites
				L	N	A			

Weather Conditions.....

Epid. 13 5C-5-41 Req 286

Fig. 10. Record Cards.

all collections were recorded as "1-39, 2-39, etc", with the "39" referring to the year and the preceding number referring to the collection. In 1940, when the collecting personnel was enlarged, further modifications were introduced so that the ticks collected by each party could be kept separate. To do this the parties were designated as Number 1 and Number 2, and the party number preceded every collection number recorded by that crew, for example, party number 1 would record its collection as "1-1-40, 1-5-40, etc", and number 2 would record its collections as "2-1-40, etc". Under this method the first number refers to the collecting party, the second number to the collection, and the last number to the year in which the collection was made.

This same system was used during 1941, and it has been adopted as the permanent method of recording tick collections.

The Shipping of Ticks to the Laboratory.

After the day's collecting is completed Rocky Mountain Spotted Fever Investigations and Daily Report cards are made out and the ticks prepared for shipping. The cards are made out in duplicate, the original going to the laboratory with the collection and the copy remaining with the crew.

In 1938 the method of shipping tick collections was quite involved and tedious. It called for the dividing of each collection into 25-tick lots. These 25 ticks were then placed in small paper salve boxes, and each box was labelled with the collection number. The salve boxes were then sealed with adhesive tape and packed in mailing tubes, usually

about 5 to a tube, and mailed to the laboratory. This method was far from satisfactory as it called for the handling of the ticks twice, and furthermore the handling of the ticks in the hotel bedroom was fraught with danger, for it was often impossible to prevent the escape of some ticks while counting them into 25 tick lots. The time taken up in making this change was also considerable.

In 1939 the method now in use was evolved. It is very efficient and the ticks are handled only once, when they are being collected. As mentioned before, when the ticks are collected they are placed in 2-inch shell vials, 100 ticks to a vial. In the field each vial is stoppered with a cork. When the day's collecting is completed and the collections are being prepared for shipment to the laboratory the cork stopper is removed and two 2-inch squares of voile are placed over the opening and fastened with adhesive tape. This allows circulation of air and also prevents the escape of the ticks. Absorbent cotton plugs were tried out but the ticks would become entangled in the fibres and caused considerable extra work at the laboratory. The collection number is marked in pencil on a piece of adhesive tape and this tape is then attached to the vial (Fig. 11). Five vials are then wrapped in absorbent cotton and placed in a mailing tube for mailing to the Laboratory. In places where the mail service is only bi- or tri-weekly, the tick collections are kept in a cool place until shipped.

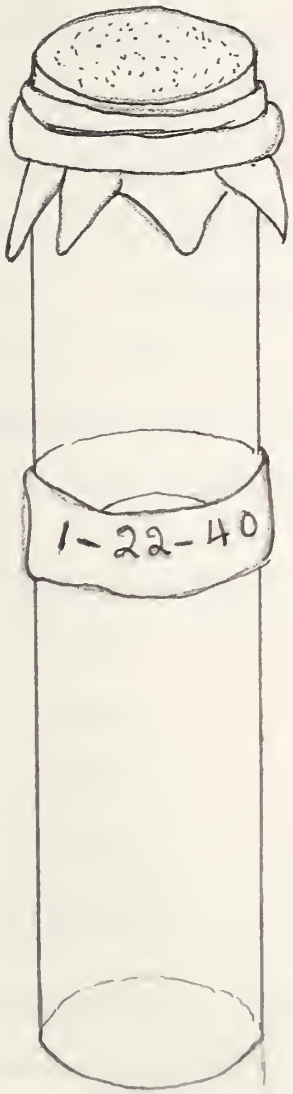


Fig. 11. Vials used for the Collecting and Shipping of Ticks.

Summary of Ticks Collected 1938--1941.

Since 1938 some 43 localities (Map 3) have been surveyed for the presence of spotted fever ticks. Many of these places have been surveyed each year, while others have only been surveyed once. Most of the collections have been confined to the area south of Township 12, with the greatest number of ticks being collected in the extreme southeast part of the province. A total of 56,795 host and drag ticks was collected in the four year period.

The following table summarizes the collections of drag and host ticks for the period 1938 to 1941.

Year.	Drag-ticks.	Host-ticks.	Totals.
1938	20,539	351	20,890
1939	11,531	886	12,417
1940	10,273	730	11,003
1941	10,609	1,876	12,485
Totals	52,952	3,843	56,795

A List of Tick Hosts in Alberta.

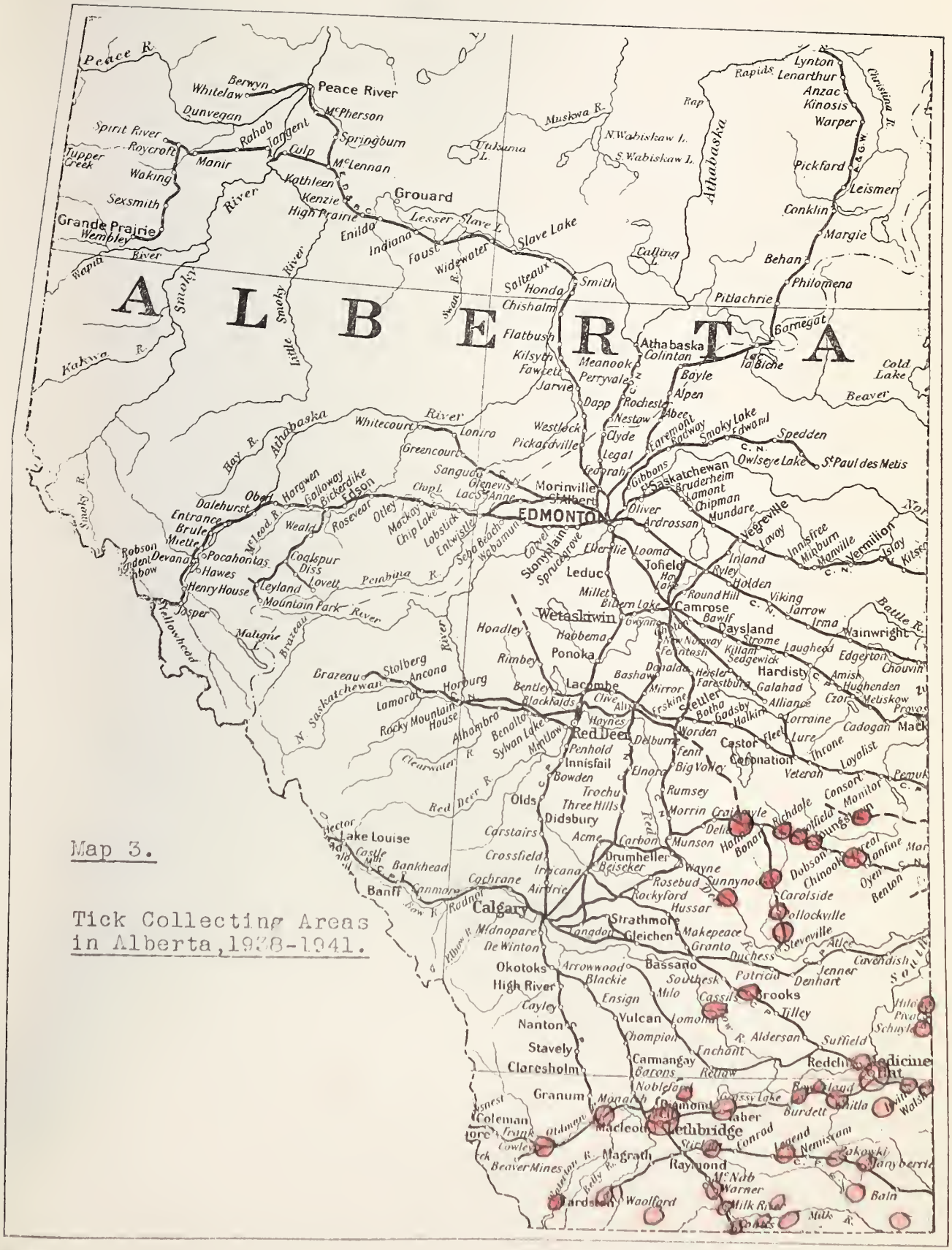
The following tick hosts are known to be present in Alberta. Seed and nymph ticks have been collected from those animals marked with an asterisk in Table 1. Adult ticks have been collected in Alberta from those animals listed in Table 2.

Table 1. Seed and Nymph Tick Hosts.

*Columbia ground-squirrel	Citellus c.columbianus.
*Richardson's ground-squirrel	Citellus richardsoni.
Thirteen-stripe ground-squirrel	Citellus tridecemlineatus pallidus.
*Mantled ground-squirrel	Callospermophilus lateralis cinarescens.
Pocket gopher	Thomomys fuscus fuscus.
Richardson's pine squirrel	Sciurus hudsonicus richardsoni.
Yellow-bellied chipmunk	Eutamias amoenus luteiventris.
White-footed mouse	Peromyscus m.artemesiae.
Meadow mouse	Microtus spp.
Red-backed mouse	Evotomys gapperi galei.
Pika	Ochotona princeps sp.
*Hoary marmot	Marmota caligata nivaria.
*Brush rabbit	Sylvilagus sp.
*Snowshoe rabbit	Lepus bairdi bairdi.
Jumping mouse	Zapus sp.
Shrew	Sorex sp.
*Jackrabbit	Lepus sp.

Table 2. Adult Tick Hosts.

Man	Homo sapiens.
Horse	Equus caballus.
Cattle	Bos taurus.
Sheep	Ovis aries.
Jackrabbit	Lepus sp.
Weasel	Mustela sp.
Richardson's ground-squirrel	Citellus richardsoni.
Columbia ground-squirrel	Citellus c.columbianus.


ALBERTA
Peace River
Berwyn
Whitelaw
Dunvegan
McPherson
Spirit River
Rahab
Tangent
Springburn
Roycroft
Manir
Culp
McLennan
Upper Creek
Waking
Kathleen
Kenzie
Sexsmith
Grouard
High Prairie
Grande Prairie
Wembley
Lesser Slave L.
Slave Lake
Enilda
Indiana
Faust
Widewater
Wapiti River
Smoky River
Little Smoky River
Kakwa R.
Solteaux
Honda
Smith
Chisholm
Flatbush
Athabaska
Colinton
Meanook
Kilsyth
Fawcett
Jarvie
Perryvale
Dapp
Rochester
Abee
Nestow
Bayle
Alpen
Pitlochrie
Bornegat
Behan
Philomena
Lynton
Lenarthur
Anzac
Kinosis
Warper
Pickford
Leismer
Conklin
Margie
Rapids
Athabaska
Muskwa R.
N. Wabiskaw L.
S. Wabiskaw L.
Utikuma L.
Calling
Cold Lake
Beaver
Whitecourt
River
Lonira
Westlock
Pickardville
Clyde
Legal
Fedorah
Gibbons
Saskatchewan
Bruderheim
Lamont
Chipman
Mundare
Vegreville
Lavoy
Innisfree
Minburn
Manville
Vermilion
Lloydminster
Spedden
Owlseye Lake
St. Paul des Metis
Smoky Lake
Edwand
Raiway
Earemont
Bay R.
Athabaska
Greencourt
Sangudo
Glenevis
Lac Ste Anne
Morinville
St. Albert
EDMONTON
Oliver
Ardrossan
Dalehurst
Obed
Hargwen
Galloway
Bickerdike
Edson
Chip L.
Otiley
Mackay
Chip Lake
Lobstick
Entwistle
Sepa Beach
Wabamun
Carvel
Stonyplain
Spruce Grove
Ellerslie
Loomd
Tofield
Inland
Ryley
Holden
Viking
Tarrow
Irma
Wainwright
Baulle R.
Leduc
Millet
Bibern Lake
Camrose
Round Hill
Bawlf
Daysland
Strome
Killam
Sedgewick
Laughead
Edgerton
Chauvin
Amisk
Hughenden
Meliskow
Provost
Cadogan
Mack
Lorraine
Fleet
Lure
Throne
Loyalist
Castor
Coronation
Veteran
Consort
Monitor
Pemuk
Entrance
Brule
Miette
Robson
Pocahontas
Coalspur
Diss
Lovett
Peabina R.
Hawes
Henry House
Leyland
Mountain Park
Jasper
Yellowhead
Maligne
Brazeau
Brazeau R.
Wetaskiwin
Hondley
Hobbema
Ponoka
Rimbey
Stolberg
Ancona
Horburg
Lamoral
Rocky Mountain House
N. Saskatchewan R.
Lacombe
Bentley
Blackfalds
Clive
Alix
Bashaw
Donalda
Mirror
Erskine
Stettler
Botha
Alliance
Hardisty
Galahad
Forestburg
Heisler
Sedgewick
Halkirk
Czar
Alhambra
Benalto
Sylvan Lake
Red Deer
Haynes
Delburne
Penhold
Innisfail
Bowden
Elnora
Big Valley
Worden
Fenn
Veteran
Throne
Cadogan
Olds
Trochu
Three Hills
Didsbury
Rumsey
Morrin
Craigmyle
Delia
Munson
Carbon
Acme
Carstairs
Crossfield
Drumheller
Beiseker
Irricana
Wayne
Rosebud
Rockyford
Hussar
Sunnynook
Carolside
Pollockville
Stevenville
Dobson
Chinook
Oyen
Benlon
Lake Louise
Castle
Bankhead
Banff
Cochrane
Airdrie
Calgary
Strathmore
Gleichen
Makepeace
Granto
Duchess
Jenner
Cavendish
Midnapore
De Winton
Okotoks
High River
Arrowwood
Blackie
Bassano
Southesk
Patricia
Denhart
Brooks
Tilley
Cayley
Nanton
Vulcan
Lomond
Champion
Aldersan
Suffield
Stavely
Claresholm
Carmangay
Barons
Retlaw
Enchant
Redcliff
Medicine Hat
Granum
Monarch
Diamond City
Grassy Lake
Burdett
Coleman
Frank
Oldman R.
Macleod
Lethbridge
Taber
Conrad
Legend
Nemiskam
Magrath
Raymond
Warner
Milk River
Bain
Woolford
Cardston
Beaver Mines
Waterton R.
Belly R.
Milk R.
Map 3.
Tick Collecting Areas in Alberta, 1938-1941.

Prophylaxis.

People who live in ,or whose work takes them into, tick-infested areas should dress so that their clothing overlaps from the bottom, that is , socks should be worn outside the trouser legs, and the jacket should be inside the waistband of the trousers. In this way ticks, which are negatively geotropistic, would be unable to work inside the clothing to the skin, and if frequent inspection of the clothing is carried out they will be easily seen and removed (1). Also, at night, a complete examination of the body should be carried out. The best way to do this is by undressing in front of a mirror so that all parts of the body can be seen. Young children, especially, should be examined carefully with particular attention being paid to the hair line at the back of the neck.

Removal of Attached Ticks.

There have been many methods devised for the removal of attached ticks, and they range all the way from the application of flame to treating with tobacco juice. Many persons insist that the application of turpentine, coal oil or gasoline will cause the tick to "back out". Other persons recommend a mixture of two or three methods.

Once a tick is attached it will remain so until the engorgement is completed, unless it is forcibly removed or the death of the host causes it to release its hold.

The method of removing an attached tick depends on the length of time the tick has been attached. If the tick has

only been attached a short time, and is not engorged to any extent, it can be removed by taking hold of the abdomen and pulling until the skin where the tick is attached forms a small tent. Then, taking a sterile razor blade or needle the skin around the insertion of the mouthparts is nicked slightly and the tick is lifted off, bringing with it a small piece of skin. If, however, the tick has been attached for a long time, and is large and putty colored, it should be excised and the wound treated. Whenever a tick is removed the site of the attachment should be treated with iodine or some other agent for asepsis (1).

II. TICK BORNE DISEASES.

Introduction.

It has been definitely established that the spotted fever tick, Dermacentor andersoni Stiles, is the transmitter of Rocky Mountain spotted fever, Tularaemia and Tick Paralysis, and the cause of infection from tick bites. In Alberta all of these diseases have been traced directly to this tick, and it is also incriminated in the transmission of a highly fatal type of tick-borne paralysis from Eastend, Saskatchewan.

Since the investigation into tick-borne diseases got under way in 1938, much information has been gathered on the relation of ticks to human health in Alberta. This information indicates that ticks are far more important than was at first thought, and that tick borne diseases are increasing in their occurrence.

Due to the peculiarity of both Rocky Mountain spotted fever and Tularaemia in infecting small native wild animals which act as reservoirs for the infection, there is every reason to believe that these diseases are increasing in the areas of infection. In fact, there is every reason to believe that these diseases are gradually spreading throughout the entire tick-infested area of Alberta.

Historical.

Rocky Mountain spotted fever was first reported from Montana and Idaho (37) in 1873. It was then known as a disease peculiar to those regions, and it was often referred

to as Rocky Mountain Typhus Fever. At that time its mode of transmission was unknown. In the period of 1902--1904 Wilson and Chowning advanced the theory that this disease was tick borne, and in 1906 Ricketts (33) demonstrated that both the male and female tick could transmit the disease.

Since 1873 Rocky Mountain spotted fever has spread over a large part of the United States. Parker (31) states that: "The total area involved is perhaps one-eighth of the continental United States". In 1935 the first authentic case was reported in Alberta.

Importance.

Rocky Mountain spotted fever is important because of its frequent occurrence, its severity, its fairly high death rate, and the prolonged period of convalescence. In some parts of Montana, Idaho and Wyoming the death-rate is about 75 percent. In Alberta about 35 percent of the cases are fatal.

Rocky Mountain spotted fever is primarily a disease of small wild animals and is transmitted to man by the bite of an infected tick. The causative organism of the disease is Dermacentroxenus rickettsi Wolbach.

The only way that spotted fever can be contracted is by the bite of an infected tick, and the severity of the disease will depend on the virulence of the organism. A highly virulent strain of the organism has been recovered from ticks collected at Manyberries.

It should be remembered that any area in which ticks occur is potentially dangerous, even though the disease has not been reported locally.

The Disease.

During the course of this investigation one case (Case number 6) of spotted fever was observed in the Medicine Hat General Hospital. The striking thing about this disease to the layman is the great weakness of the patient and the profusion of purple spots on the skin.

As the disease is in the field of the medical profession no attempt will be made to describe it from personal observation. The following description is that set forth in a bulletin prepared by the Alberta Department of Public Health (1).

" The period between the tick-bite and the first symptoms of infection (the incubation period) varies from 2 to 14 days. In those areas where the disease is severe it is usually 3 to 5 days, but where the less fatal infection predominates it is commonly 5 days or longer. The onset may be gradual over a period of one day or more, or it may be sudden. If gradual, as is usually the case, the appearance of the fever is preceded by a period that is mainly characterized by increasing weakness, but there may also be chilly sensations. A definite chill frequently follows. With the appearance of the fever some of the following symptoms are present: headache in the front or back of the head, or both; eyes more or less bloodshot and often sensitive to

light; eyeballs sensitive to pressure; the tongue coated white with red edges; face with deep, dusky flush; pains in the muscles, bones and joints; backache, particularly in the lower portion; nose bleed; bronchial cough; vomiting; constipation; marked weakness. In the case of the highly fatal type the rise in temperature may be accompanied by a considerable increase in the pulse rate, but in the areas where the milder type prevails, the pulse rate does not reach 100. The characteristic eruption, from which the common name of the disease is derived, commonly appears between the third and fifth day of fever and is usually seen first on the hands and forearms, or on the ankles and legs--- less often on the back. This eruption is due to the breaking down of the walls of the small blood vessels in the skin and the resulting escape of blood."

The diagnosis can be confirmed by a blood test carried out at the Rocky Mountain Spotted Fever Laboratory at Hamilton, Montana (1).

Treatment.

There is no specific treatment. Rest and quietness and the usual fever treatment is indicated.

Prevention.

There are two methods of prevention that can be used. The first is prophylaxis and the second is vaccination.

Prophylaxis (See page 25) is recommended for those persons who rarely enter tick-infested areas, but all of those persons living or working in heavily tick-infested areas

should be vaccinated with spotted fever vaccine. This vaccine is prepared at the Rocky Mountain Spotted Fever Laboratory, Hamilton, Montana, from the tissues of infected ticks. It will confer immunity for one year against the milder type of the infection, and will give some protection against the more severe type. The vaccine can be secured by Alberta doctors, free of charge, from the Provincial Department of Public Health.

The vaccine is used in two 2-c.c. doses given 5 days apart, either sub-cutaneously or intramuscularly. Usually the reaction is local, but in some persons it is constitutional and ocassionally severe (1).

Vaccination in Alberta.

The first recorded use of spotted fever vaccine for prevention purposes in Alberta was in March, 1938, when this investigator was vaccinated prior to undertaking the investigation. In 1939 two persons were vaccinated. In 1940, after it had been demonstrated that spotted fever infected ticks were present in both the Manyberries and Lethbridge areas, a fairly large number of Dominion and Provincial government officals were vaccinated. All members of the tick-collecting parties are vaccinated at the beginning of each season.

After the finding of ticks infected with a highly virulent strain of spotted fever in the Manyberries area in 1939, an educational campaign was undertaken with the aim of convincing the residents of that area of the necessity

of protecting themselves by means of the vaccine. This campaign aroused considerable interest, and all signified their willingness to be vaccinated. Unfortunately, due to poor crops and excessive insect damage, the people were not in a position to meet the cost of the vaccination.

The Department of Public Health, desirous of protecting the people in this area and at the same time realizing that the people were in no position to meet the extra cost, made arrangements to vaccinate, free of charge, all those persons who presented themselves to the doctor in Manyberries on certain stated days in April, 1941. Doctor H.C.Dixon of Medicine Hat was employed to administer the vaccine.

The response by the residents of the area was very gratifying and a total of 161 persons were vaccinated. The following table sets out the number vaccinated in age groups and number of doses (4).

Age Groups.	First Dose.	Second Dose.
Adults----------	60	33
Young adults----------	27	20
17 years and under----------	74	52
Totals	161	105

Reaction to the Vaccine.

The reaction to the vaccine varies with the individual. The following notes deal with those cases that came under personal observation.

1st. J.H.B., 32 year old male, received first dose of vaccine on March 24, 1938, in left arm. The arm became swollen and very sore. The second dose was divided into two inoculations of 1 c.c. each, and were injected into the left and right belly muscles. These muscles became very sore and a general body soreness was manifested. The third dose of 1 c.c. was given in the right arm. Considerable generalized soreness, weakness and nausea was present and the patient remained in bed for two days. This patient appeared to be allergic to tick protein.

2nd. F.OM., 30 year old male, received first dose in May, 1939. No general reaction until following day when some soreness was present. The second dose gave no ill effects.

3rd. J.H.B.,33 year old male, received first dose of vaccine in left arm in May,1939. As the previous reaction (See 1 above) had been very severe only 1 c.c. was taken. The reaction was quite severe and general weakness and soreness followed. The required 4 c.c. of vaccine was taken in 4 doses, but there was a marked reaction each time.

4th. G.F.M., 35 year old male, received first dose in left arm in May,1940. The arm became very swollen, hard and painful, and there was a general weakness and nausea.

5th. J.H.B.,34 year old male. Three doses of 1 c.c. each of the vaccine were taken,but the feaction was still severe.

6th. W.R.F., 26 year old male, received first dose in May, 1940. No marked reaction. No ill-effects from the second dose.

7th. G.D.R., 21 year old male, received first dose in May,1940. Quite a severe reaction with soreness in arm. Second dose less severe.

8th. G.C.W., 24 year old male,received first dose in May,1940. The reaction was very sudden with the patient becoming very weak and remaining in bed for half a day. The arm was quite sore. Second dose somewhat milder.

9th. J.H.B.,35 year old male, received first dose in April, 1941. In view of the marked severity of the previous reactions only two doses of 1 c.c. each were taken. The reaction was still quite severe. It is apparent that this person is allergic to tick protein.

10th. W.R.F., 27 year old male, received first dose in April, 1941. No marked reaction from either first or second dose.

11th. G.D.R., 22 year old male, received first dose in April, 1941. No marked reaction but a slight soreness in the arm.

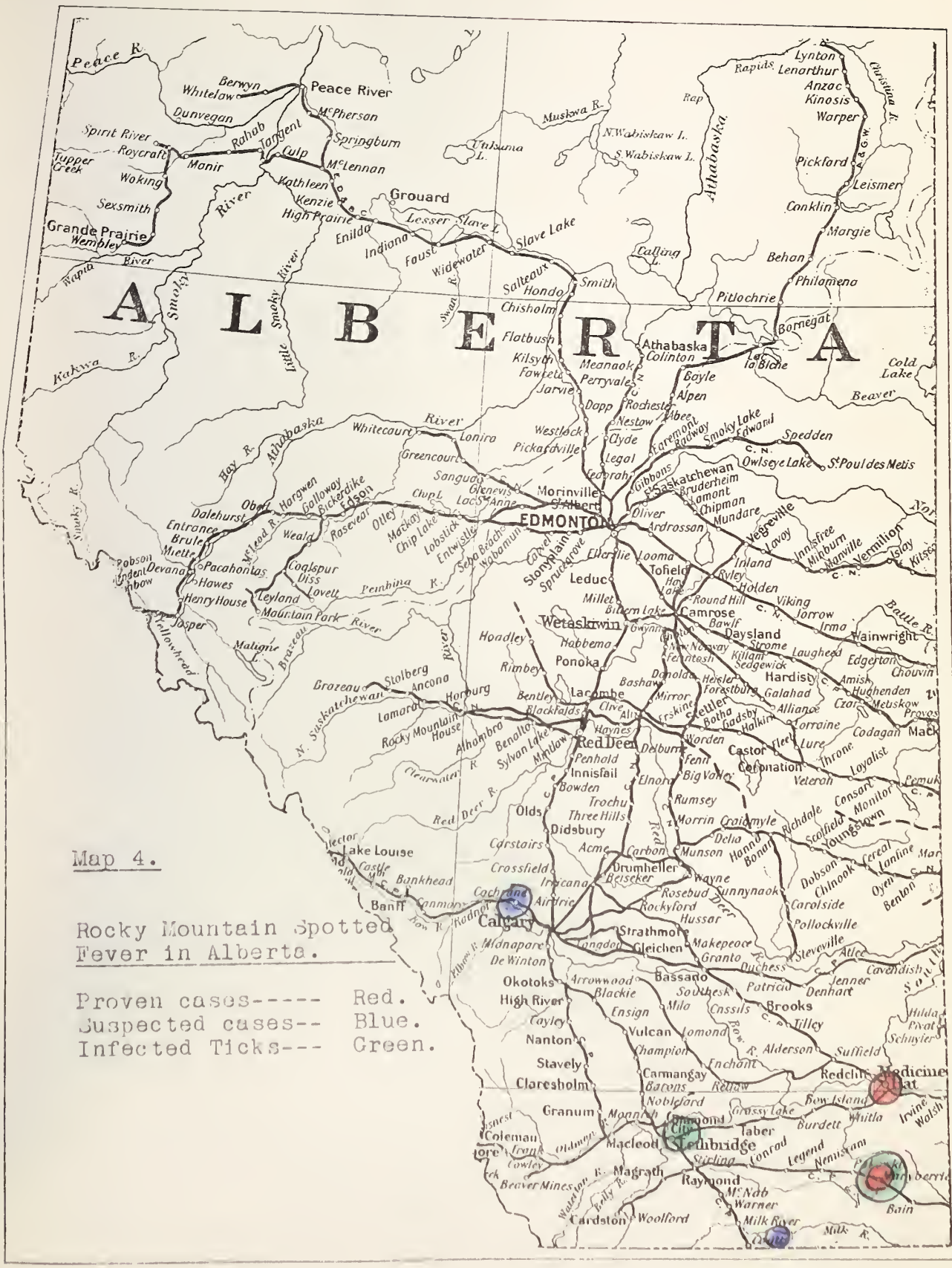
12th. G.C.W.,25 year old male,received first dose in April, 1941. Considerable reaction and arm very sore. Less reaction with second dose.

Dr.H.C.Dixon, the doctor in charge of the vaccination campaign at Manyberries in April,1941, kept notes on the vaccine reactions. He states that of the 161 persons vaccinated 5 had severe reaction, 33 had slight reaction, and the remainder had no particular reaction other then a slight soreness in the arm (4).

Rocky Mountain spotted fever in Alberta.

There is considerable confusion in regard to the actual number of cases of this disease that have occurred in Alberta, and also as to the date of the first case. This confusion is due largely to the fact that until 1935 spotted fever was believed to be confined to the mountainous regions of the United States.

Since 1935 eight known and suspected cases of this disease have been located, and of these three have been fatal. These cases were reported from Aden (near Milk River), Medicine Hat, Cochrane and Manyberries (Map 4).


ALBERTA
Peace R.
Peace River
Berwyn
Whitelaw
Dunvegan
McPherson
Spirit River
Rahab
Tangent
Springburn
Roycraft
Culp
Manir
McLennan
Woking
Kathleen
Sexsmith
Kenzie
Grouard
High Prairie
Grande Prairie
Wembley
Enilda
Indiana
Lesser Slave L.
Slave Lake
Faust
Widewater
Wapiti River
Smoky River
Little Smoky River
Kakwa R.
Swan R.
Salteaux
Hondo
Smith
Chisholm
Flatbush
Kilsyth
Fowcett
Jarvie
Meanook
Perryvale
Athabaska
Colinton
Boyle
Dapp
Rochester
Athabaska R.
Whitecourt
River
Loniro
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Otley
Mackay
Chip Lake
Lobstick
Entwistle
Sepo
Beach
Wabamun
Carvel
Stonyplain
Sprucegrove
Ellerslie
Looma
Tofield
Inland
Ryley
Holden
Viking
Jarrow
Irma
Wainwright
Battle R.
Leduc
Millet
Bittern Lake
Camrose
Bawlf
Daysland
Strome
Killam
Sedgewick
Laughead
Edgerton
Chauvin
Hobson
Ardent
Rainbow
Pacahontas
Hawes
Devana
Coalspur
Diss
Lovett
Pembina R.
Leyland
Henry House
Mountain Park
River
Jasper
Yellowhead
Brazeau
Malligne L.
Hoadley
Habbema
Wetaskiwin
Ponoka
Rimbey
Hardisty
Amisk
Hughenden
Galahad
Metiskow
Provost
Grozeau
Stolberg
Ancona
Horburg
Lacombe
Bentley
Blackfalds
Clive
Alix
Lamard
Rocky Mountain House
N. Saskatchewan R.
Athambra
Benalto
Sylvan Lake
Haynes
Red Deer
Mirror
Forestburg
Alliance
Czar
Lorraine
Codagan
Mack
Gadsby
Halkirk
Delburne
Penhold
Innisfail
Bowden
Elnora
Big Valley
Castor
Coronation
Throne
Loyalist
Veteran
Clearwater R.
Red Deer R.
Olds
Trochu
Three Hills
Didsbury
Rumsey
Morrin
Craigmyle
Richdale
Consort
Monitor
Youngstown
Scotfield
Carstairs
Acme
Carbon
Munson
Delia
Hanna
Bonar
Lake Louise
Castle
Bankhead
Crossfield
Irricana
Beiseker
Drumheller
Wayne
Rosebud
Sunnynook
Dobson
Chinook
Cereal
Lanfine
Oyen
Banff
Cochrane
Airdrie
Calgary
Rockyford
Hussar
Carolside
Pollockville
Strathmore
Langdon
Gleichen
Makepeace
Granto
Duchess
Stevenville
Atlee
Cavendish
Jenner
Midnapore
De Winton
Okotoks
Arrowwood
Bassano
Patricia
Denhart
High River
Blackie
Ensign
Mila
Cassils
Brooks
Tilley
Cayley
Vulcan
Lomond
Champion
Nanton
Alderson
Suffield
Stavely
Enchant
Camrose
Claresholm
Bacons
Redcliff
Medicine Hat
Noblefford
Bow Island
Granum
Monarch
Grassy Lake
Burdett
Whitla
Irvine
Walsh
Coleman
Taber
Lethbridge
Macleod
Conrad
Legend
Nemiskam
Magrath
Raymond
McNab
Warner
Cardston
Woolford
Milk River
Milk R.
Bain
Map 4.
Rocky Mountain Spotted Fever in Alberta.
Proven cases----- Red.
Suspected cases-- Blue.
Infected Ticks--- Green.

It is apparent that Manyberries is the worst area of infection as four of the cases and all three deaths have occurred there. The three fatal cases lived close together on the North Branch of the Manyberries Creek while the other case lives about one mile west of this area. The homes of two of the fatal cases and the recovered case can be seen in Figure 5.

In 1939 a highly virulent strain of spotted fever infection was recovered from ticks collected in the North Branch of the Manyberries Creek, and a milder strain was found in ticks taken near the home of the recovered case (4).

The following information on the known and suspected cases of Rocky Mountain spotted fever has been gathered from hospital records, doctor's records, and from interviews held with the patients or with the relatives of the patients.

1st. H.E., an elderly farmer living on the North Branch of the Manyberries Creek. Admitted to Medicine Hat General Hospital July 25, 1935. Died July 30, 1935.
Diagnosis:- Rocky Mountain spotted fever.
Doctor:- Dr.H.C.Dixon.

2nd. Mrs.J.G., a young married woman living at Aden,near Milk River. Contracted what is thought to have been a mild case of spotted fever from tick bites.
Diagnosis:- Not definite.
Doctor:- Dr.H.B.Hunt.

3rd. L.L. a young married man living on North Branch of Manyberries Creek, took sick following tick bites and died. 1936.
Diagnosis:- Not definite.
Doctor:-

4th. J.M.,age 55, farmer living 1 mile west of the North Branch of the Manyberries Creek. Admitted to Medicine Hat General Hospital on June 29th,1936. Discharged July 31st,1936.
Diagnosis:- Rocky Mountain spotted fever.
Doctor:- Dr.Gershaw.

5th. J.C., age 61, farmer living on the North Branch of the Manyberries Creek. Admitted to the Medicine Hat General Hospital July 21st, 1936. Died August 1st,1936.
Diagnosis:- R.M. spotted fever.
Doctor:- Dr.Gershaw.

6th. E.B., 18 year old male living in Seven Persons Coulee near Medicine Hat. Entered the General Hospital in early part of July,1940. Discharged as recovered.
Diagnosis:- R.M. spotted fever.
Doctor:- Dr.MacCharles.

7th. M.T., 20 year old female living in Calgary visited the Cochrane area about May 24th,1940. On May 31st,1940, she was admitted to the Holy Cross Hospital, Calgary. She was discharged June 21st,1940.
Diagnosis:- Rocky Mountain spotted fever.
Doctor:- Dr.E.P.Scarlett.

8th. W.H.B., age 32, Lineman. Spent some time in the Morley district around September 1st,1940. Admitted to Calgary General Hospital September 6th,1940. Discharged as recovered.
Diagnosis:- Rocky Mountain spotted fever.
Doctor:- Dr.I.H.Brodie.

Of the cases listed above 1,3,4,5 and 6 are considered as being definite cases of Rocky Mountain spotted fever. Cases 1,3,4 and 5 occurred in an area where spotted fever infected ticks have been found, and case number 6 was determined on blood tests as well as clinical grounds.

III. TULARAEMIA.

Historical.

Tularaemia, which is also known as rabbit fever and deer-fly fever, was first specifically diagnosedd in an Ohio case in 1914 (30). In 1919 Francis (30), working in Utah, was able to demonstrate that a deer-fly borne disease in that state was tularaemia. The first Montana case was reported in 1925 (30). Since 1931 about 20 cases have been reported in Alberta.

Tularaemia is not so frequently fatal as spotted fever, but it is nevertheless a very serious disease and convalescence may extend over a period of many weeks (1). It is primarily an infection of small wild animals and is known to be transferred to man by the handling of infected animals, by the bite of the deer-fly, Chrysops discalis Will., and by the bite of the spotted fever tick, Dermacentor andersoni Stiles. It is transmitted from animal to animal in nature by the rabbit tick, Haemaphysalis leporis-palustris Packard, and by the spotted fever tick, Dermacentor andersoni Stiles.

The causative organism of tularaemia is Pasteurella tularense, and was first described by McCoy and Chapin in 1912.

Tularaemia in Alberta.

Since 1931 about 20 cases of tularaemia have been reported in Alberta (Map 5), but only two of these cases were caused by tick bites. All of the other cases were due to handling infected animals or from the bite of a deer-fly.

Two tick-borne cases occurred in the Medicine Hat district

in 1939 and 1940.

The first case was a 35 year old shepherd from Walsh. This man was bitten by ticks during the early part of May, 1939, and entered the Medicine Hat General Hospital on May 11th. He was discharged on July 2nd, 1939.

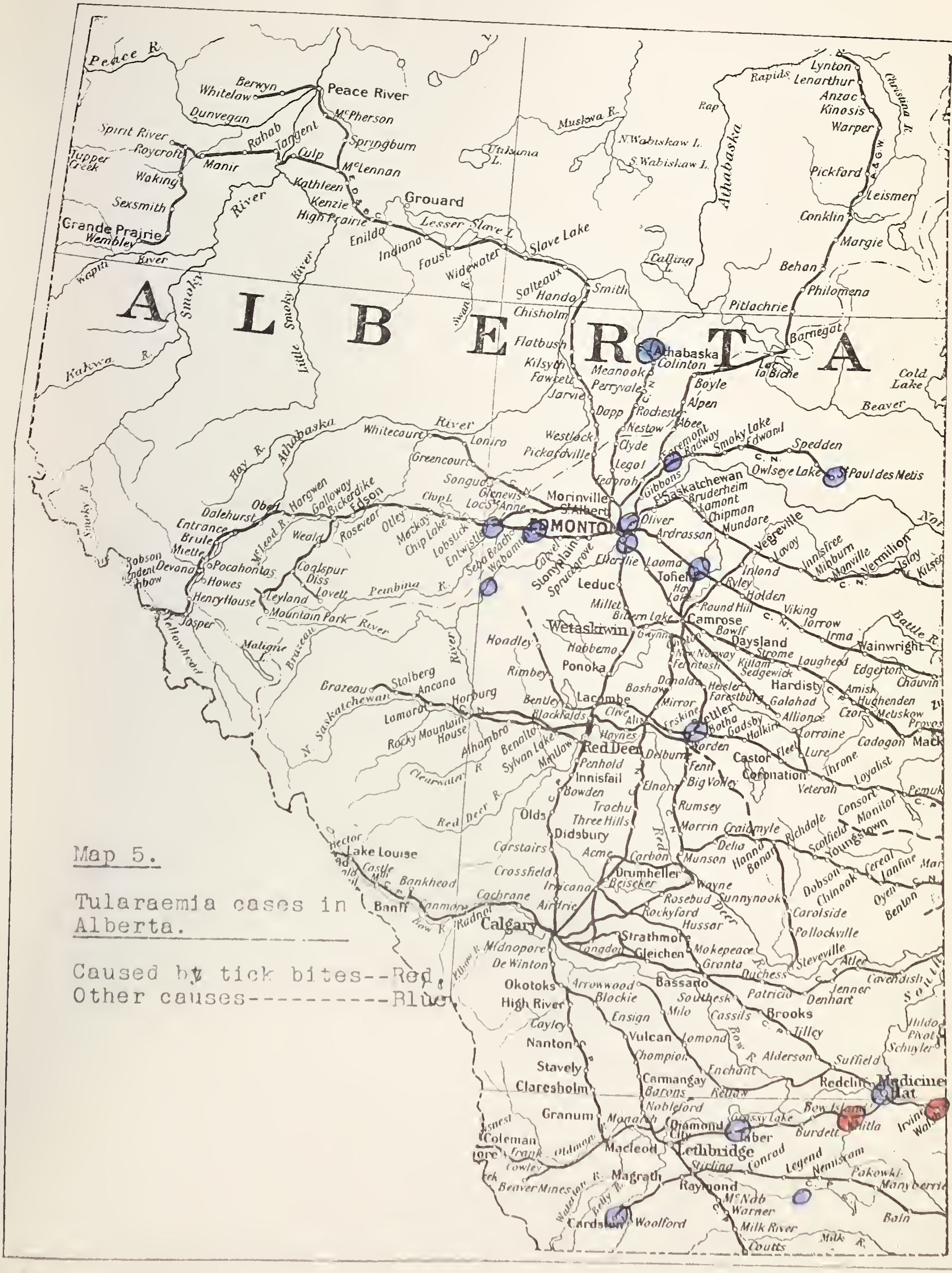
The second case was a 35 year old married woman from the Whitla district. She was bitten by ticks about June 1st, 1940, and the lesions were plainly noticeable when she entered the Medicine Hat General Hospital on June 7th. Blood tests carried out at the Provincial Laboratory in Edmonton showed a very high titre of agglutinins. She was discharged some time after July 9th, 1940.

Another suspected case, though tularaemia was not proven, occurred in a 15 year old boy in 1939. This boy lived in the Milk River district and was taken to the Shelby,Montana, hospital on April 19th,1939. There was a definte history of tick-bites but no further information could be obtained.

As a check on the Walsh and Whitla cases, tick collections were made in their immediate neighborhood. Both of these collections showed a very high percentage of tularaemia-infected ticks.

From 1938 to 1941, twelve tick collections made at Manyberries, Milk River, Walsh and Whitla were infected with Pasteurella tularense, the tularaemia organism.

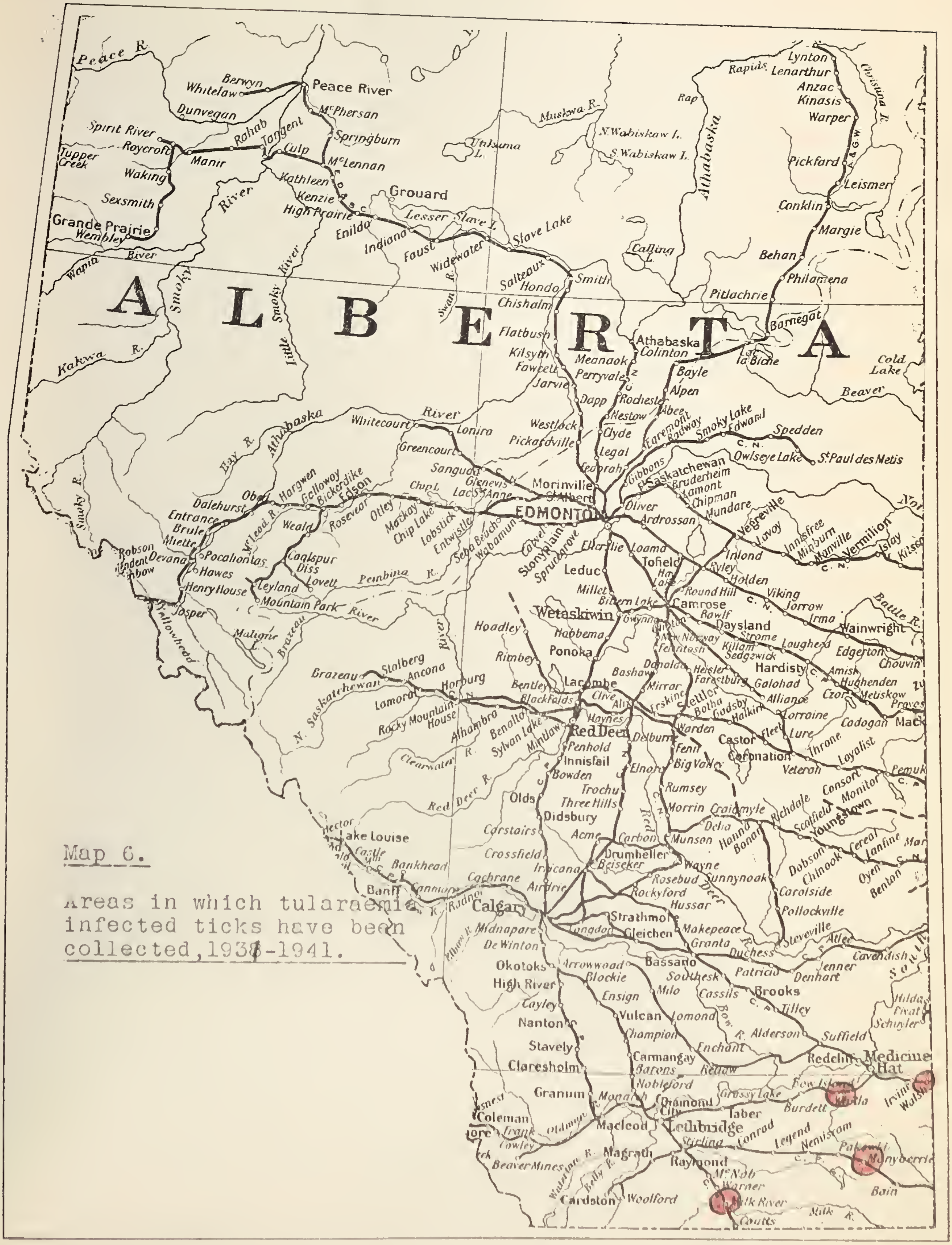
Ticks are next in importance to rabbits as a source of infection, because not only is their bite infectious but also their excrement. Thus it is possible to contract the infection by soiling the hands with the excrement and body tissue:



Map 5.

Tularaemia cases in Alberta.

Caused by tick bites--Red.
Other causes----------Blue.



Map 6.

Areas in which tularaemia infected ticks have been collected, 1938-1941.

while removing ticks from horses or other animals.

The Disease.

Although two cases of tularaemia came under personal observation, the following description of this disease is as set forth by Parker (30), and in the bulletin (1) issued by the Alberta Department of Public Health.

It should be noted that the two Alberta cases of tick-borne tularaemia were of the "typhoidal" type.

" Tularaemia in man sometimes follows a sub-acute course that approaches chronicity. Two principal types, glandular and typhoidal, have been distinguished on clinical grounds, but the course of infection is much the same in both.

In the glandular type, which is the most common, there is an enlargement of certain of the regional lymph glands which may or may not proceed to suppuration. That is, if the site of infection is one of the hands then the glands in the elbow or in the axilla are usually the ones affected. The site of infection is often marked by a papule which later becomes an ulcer of the skin. Infection sometimes occurs through the tissues of the eye due to the rubbing of the eye with fingers contaminated with infectious material such as animal tissue or tick excrement. In such cases the eye may be severely affected and the glands on that side of the face or neck are the ones that become enlarged. Occasionally infection is acquired by way of mouth, as for instance, by the eating of insufficiently cooked meat of an infected rabbit. In such cases there is no local ulceration or enlargement of

external glands.

The location of the ulcer that marks the site of the infection depends to a considerable extent upon the infecting agency. If this is a tick, the ulcer is likely to occur on any part of the body except the feet; if a deer-fly, on any exposed part of the body, as the neck, face, hands, or arms; if from contamination through handling animal tissues, it is usually on one of the hands. Tick bite cases occur in spring and early summer; deer fly cases, in summer and early autumn; and cases caused by handling infected animals, at any season of the year, but most frequently during spring and summer.

The average incubation period is about three days, but may be as short as one day or as long as nine. The onset is usually sudden and is characterized by headache, chills, or chilly sensations, muscular pains, vomiting, sweating, fever and prostration. The usual febrile period is two or three weeks, but may be much longer. There is an initial fever which lasts one to three days. This is followed by a remission of one or more days duration which is accompanied by a general amelioration of symptoms. A secondary rise of temperature follows, then a gradual decline to normal. Prostration is marked and there is a continually increasing weakness. A skin eruption is present in only a small percentage of cases. If present, it is most frequently confined to the upper portion of the body. Its character is not constant, and it may be popular.

Convalescence is slow and if the course of infection is

at all severe it is usually several months before the patient is able to perform full time work. Return to normal health may require a year or even longer in extreme cases. Relapses, eight months after the original infection, have occurred in cases of the typhoid type.

Tularaemia has been confused with glanders, typhoid fever, influenza, septic infection, sporotrichosis, undulant fever, and tuberculosis."

Diagnosis may be confirmed by an agglutination test which can be made at the Provincial Laboratory in Edmonton. Blood for this test should not be taken before the middle of the second week of illness, agglutinins being absent during the first week. Agglutinins are persistent and have been demonstrated in the blood as long as 18 years after recovery.

Treatment.

There is no specific treatment for this disease. Physicians, however, can relieve the symptoms is some measure. Complete rest in bed is of the greatest importance. Relapses are not uncommon and may occur six months or longer after the original illness (1).

Prevention.

There is no safe vaccine as yet but work is being carried on directed toward this end. Animals found dead, especially rabbits (Fig.12), should not be handled, and after handling any dead animal in a known or suspected tularaemia area care should be taken to cleanse the hands as soon as possible. In tick-infested areas proper clothing and nightly examination are indicated.

Fig. 12. Rabbit found dead in Tularaemia-infected area near Milk River.

IV. TICK PARALYSIS.

Historical.

Tick paralysis is a little-known disease that has occurred in both Alberta and British Columbia (17). It is transmitted by the spotted fever tick, D. andersoni Stiles, and occurs in man, cattle and sheep.

Very little is known about this disease, which results in a paralysis of the motor nerves, but it is commonly believed that it is caused by a toxin injected by the tick rather than by a pathological organism. It follows the bite of either female or male ticks---- at one time it was held that only female ticks produced the disease--- but the bite of the female tick appears to be the more severe. It has not been determined as yet whether all ticks of this species are potential producers of tick paralysis, or if only certain ones can bring about this condition. From the rarity of the disease it appears that the ticks that can produce the condition are the exception rather than the rule.

Two cases of tick paralysis in man, and two in sheep have been known to occur in Alberta since 1938.

Tick Paralysis in Man.

Todd (39) while working on the effect of tick bites on human beings recorded the occurrence of a paralysis that has become known as tick paralysis. Mail and Gregson (17) recorded a number of cases that have occurred in British Columbia. Two cases of this disease have occurred in Alberta.

The first case of this disease in Alberta affected a

young girl from the Cypress Hills district. She was treated by a Medicine Hat doctor and made a complete recovery.

The second case occurred in 1940 when a 21 year old male, a member of the investigating party, developed a partial paralysis of the left arm. A complete and detailed examination of the body revealed a male tick attached in the left axilla. Within twelve hours of the removal of this tick the paralysis had disappeared, but a slight soreness in the stomach muscles on the left side persisted for two or three days (4).

The Disease.

Tick paralysis occurs more often in children than in adults, and it also affects such domestic animals as cattle, sheep and dogs. It follows the bite of a tick and the initial symptoms usually appear about the fourth day after tick attachment.

The following description of the disease is taken from a bulletin prepared by the Alberta Department of Public Health.

" As observed in children, the first symptom is generally a lack of co-ordination of the legs. The child is soon unable to stand. The paralysis gradually ascends and in a few days involves the muscles of the trunk and head. The involvement of the throat muscles affects swallowing and speech becomes difficult. Breathing may be labored. Usually there is only a slight rise in temperature. The paralysis progresses rapidly, in the case of children, at least, and death is certain to occur in a few days unless the tick is removed before the respiratory muscles become too severely involved. On the other

hand, if the tick is found and removed early, improvement is rapid.

Occasionally, especially in persons of mature age, the paralysis is localized, involving only an arm or leg. In such instances the effects are less serious.

The tick concerned, which is the spotted fever tick, is generally attached to some hairy portion of the body, particularly the head."

Treatment.

There is no specific treatment other than the removal of the tick. The important point to bear in mind if a child develops an apparent condition of paralysis is that it may be due to a tick. An immediate search for the tick should be made and if one is found it should be removed and the site of attachment treated with iodine or some other antiseptic.

Prevention.

In tick infested areas small children should be examined nightly for the presence of ticks. Particular attention should be paid to the back of the neck and head.

Tick Paralysis in Sheep.

Hadwen (13) recorded the first occurrence of tick paralysis in Canada in 1913, and many cases have been reported in British Columbia since that time.

From information gathered since 1938 there is every reason to believe that tick paralysis in sheep is far more common in Alberta than is generally realized. Sheep men in the

tick-infested areas report that they lose many sheep every spring from some type of paralysis.

The first personally observed case (Fig.13) occurred in the Manyberries district in the spring of 1938. There is a heavy loss of sheep in this district every spring from some type of paralysis.

The second case occurred in the Milk River area in the spring of 1939.

Both of these cases showed typical symptoms of tick paralysis.

V. A TYPE OF PARALYSIS FROM EASTEND, SASKATCHEWAN, THOUGHT TO BE CAUSED BY THE BITE OF THE SPOTTED FEVER TICK (4).

Since 1938 there have been three cases of paralysis from Eastend, Saskatchewan, admitted to the Medicine Hat General Hospital for treatment. Two of these cases were fatal. In each case there was a definite history of tick bites, but no ticks were recovered. All of the cases were males.

The following is a short summary of each case:-

1st. J.R., 46 year old farmer from Eastend, Saskatchewan, admitted to hospital September 6th, 1938. Died September 8th, 1938.

2nd. J.H., 16 year old male. Worked at Eastend during July. Admitted to hospital July 27th, 1939. Died July 29th, 1939.

3rd. R.W.S., 21 year old civil engineer. Worked at Eastend during summer of 1939. Admitted to hospital August 7th, 1939. Recovered.

Fig. 13. Sheep Paralyzed with Tick Paralysis.

VI. INFECTED TICK BITES.

There are many records of infected tick bites in southern Alberta. Some of these were comparatively mild, while others were so severe that hospitalization and operative treatment was necessary. Persistent ulcers are sometimes produced, but usually the infection is of such a nature that ordinary treatment is sufficient (28). All tick bites should be treated with the usual asepsis procedure.

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PART 2.

BUBONIC PLAGUE AND FLEAS IN ALBERTA.

ABSTRACT.

During the course of the four year investigation 9,329 fleas and 269 tissue specimens were collected from 5,357 ground-squirrels. Of these, 3 tissue specimens and 6 flea collections were demonstrated, on laboratory examination, to be infected with Pasteurella pestis, the plague organism.

Two plague areas, one at Stanmore and the other at Youngstown, a distance of 28 miles apart, were shown to be present in the province. Both of these areas were posted with warning placards.

The investigation into the fleas of Alberta, a study which is not as yet complete, shows that 3 families, 13 genera, and 15 species are common in the province; and of these, four species are known plague vectors. The finding of a human flea, Pulex irritans Linn., on a badger in the Stanmore plague area is of great interest as it is held that this species can transmit plague to man.

The Ground-Squirrel Control Campaign that was operated in the Stanmore plague area during 1940 was very successful, and it is estimated that between 60 and 75 percent of the ground-squirrel population was killed.

VIII. PLAGUE.

Historical.

Bubonic plague is the Black Death of history which occurred in successive waves of epidemics during the middle ages and culminated in the great outbreak in the City of London in 1665, where it took a toll of over fifty percent of the population.

The origin of bubonic plague is lost in antiquity, and there is some doubt as to whether it is a disease of rodents that has been transferred to man, or whether it is a disease of man that has been transferred to rodents, for it is equally fatal to both.

Many of the early workers noticed that there was a similarity between a plague-like disease that attacked rats and plague in man, but it was not until 1894 that Yersin isolated the causative organism, Pasteurella pestis, and showed that the two diseases were identical. Kitasato, working independently, also recovered the organism Pasteurella pestis. The discovery that these two diseases were the same aroused considerable speculation as to the method of transmission, and in 1898 Simond suggested that fleas were the transmitters. In 1905 Liston demonstrated that the organism readily developed in the alimentary canal of the Indian rat flea, Xenopsylla cheopis Glinkewicz. In 1906--1907 the British Plague Commission working in India showed that fleas play an important part in the spread of plague. Bacot and Martin in 1914 discovered the method whereby fleas transmitted plague from rat

to rat, and from rat to man.

Since the great epidemic of 1665, smaller outbreaks have occurred in various parts of the world. In 1894 a serious outbreak occurred in the great seaport of Hong Kong, and it is believed that this was the source of infection for all outbreaks since that time.

Plague was reported in Bombay in 1896; in Egypt in 1898; in Manila, Buenos Ayres, and Rio de Janeiro in 1899; in California in 1900; and in Alberta in 1939.

There are many endemic centres of plague throughout the world, and the principal ones are located in China, southeast Russia, India, South America, Africa and North America. In North America the area appears to embrace all of the Pacific United States and extends into Alberta, Canada.

Importance.

Bubonic plague is one of the most serious of human diseases and is usually fatal. It can be contracted by handling infected rodents or by the bite of an infected flea. The disease usually appears first as an epizootic amongst the rodents, and then as these die their fleas, which are usually infected, seek new hosts and in many cases will attack man, transferring the infection to him. Not all rodent fleas can transfer the disease, but those species that transfer it from animal to animal will usually act in a similar capacity between animal and man.

The history of the sole Alberta case of plague in man indicates that the infection was contracted by handling

infected animals.

It has been demonstrated that plague can be present in a quiescent state amongst the rodents, and when conditions are favourable it will flare up into a serious outbreak.

The Disease.

The causative organism of plague is Pasteurella pestis, and the disease may appear in humans in three different forms; bubonic, pneumonic, and septicaemic (#33).

The bubonic type occurs when the infection localizes in the lymph glands of the arm pit or groin, and causes them to swell until they attain a size of from one to two inches in diameter. This is considered to be the mildest form of the disease.

The pneumonic type, which is highly infectious and usually fatal, is the most serious form of the disease. It is produced by the bubonic type of plague invading the blood stream and setting up a secondary pneumonia.

The septicaemic type usually causes death before the plague symptoms appear. This type often results from the invasion of the blood stream by the bubonic type.

Of the three types the pneumonic is by far the most serious, for although in all probability in nature plague is usually transmitted by infected fleas there is no doubt but that during epizootics droplet infection is the main cause of the rapid spread of the disease. When the pneumonic type develops in man, persons coming into close contact with

Numbers refer to bibliography at the end of Part 2.

the patient will be exposed to the disease by means of droplet infection. This can be the potential source of an epidemic.

History of Plague in North America.

In 1900 an outbreak of plague occurred in California. Eskey and Haas (12), state that, "In March,1900, Dr.W.H.Kellogg of San Francisco recognized the first human case of plague reported in the United States." This outbreak is considered to have been due to an infection transferred to local rats by diseased rats that escaped from a ship lately arrived from an Asiatic port. This outbreak persisted from 1900 to 1908 and caused 293 human cases of which 191 were fatal (12).

It is now believed that during this outbreak the disease was transmitted from rats to the California ground-squirrels, Citellus beecheyi, a close relative of the rat, either by infected fleas or by droplet infection. In any case the disease became well-established in ground-squifrels, and it has been definitely proven that ground-squirrel fleas can, and do, transmit the disease from one animal to another.

Since 1900 plague infected ground-squirrels have been located in small areas in California, Washington, Idaho, Oregon, Nevada, New Mexico and Montana in the United States (12), and in Alberta, Canada (22,6).

History of Plague in Alberta.

The first indication that plague might be present in Alberta occurred during August, 1937, when C.H., a 30 year old mink farmer of Stanmore (near Hanna), died from some disease highly suggestive of plague.

This man, following the usual practice of fur farmers, was feeding his mink on the common prairie gopher or Richardson's ground-squirrel, Citellus richardsoni Sabine (Fig.1). These ground-squirrels were being shot and trapped in the vicinity of Old Man Lake.

During the latter part of July,1937, the mink began to sicken and die, and at the same time C.H. noticed dead ground-squirrels in the Old Man Lake area. He stopped gathering ground-squirrels in this region and located a new food supply south of the town. But in the meantime 22 of his mink died. This was a very serious loss but he pelted the dead animals so that some return could be had.

While pelting an animal on August 3rd, 1937, he cut his knuckle with the pelting knife. He immediately treated the cut with iodine but continued with the pelting. ON August 5th he complained of feeling ill. On August 6th he had a very high fever and was taken into the Hanna Hospital by Miss H.MacArthur, the provincial district nurse. On August 8th he died in an ambulance on the way to a Calgary hospital.

At the time it was impossible to determine the exact cause of death, but it appeared to be definitely related to the disease that caused the death of the mink, which in turn, appeared to have some relationship to the death of ground-

squirrels in the area of mink food supply.

As soon as this death was reported to the Department of Public Health, that body decided that an investigation into circumstances surrounding the death should be carried out.

It was decided that the investigation should follow the same general plan of operation as conducted in California, with the purpose of collecting fleas and ground-squirrel tissue specimens in the suspected plague area.

Summary of Field Investigations.

The field investigation came into operation in the summer of 1938. The investigating party consisted of two specially trained men equipped with a travelling laboratory (Fig.2), and the purpose of the field work was to collect and examine ground-squirrels for indications of Pasteurella pestis infection. Ground-squirrel fleas were to be collected, and tissue specimens, consisting of samples of glands, heart, liver, lung and spleen, were to be taken from sickly or suspicious appearing animals. All fleas and tissue specimens were to be sent to the Virological Laboratory at Kamloops for bacteriological examination.

During the investigation in the Stanmore area in the summer of 1938 a total of 140 ground-squirrels were collected. These ground-squirrels yielded 360 fleas and one tissue specimen. No indication of plague infection was found.

In 1939 the Stanmore area was again investigated, and 191 fleas and 13 tissue specimens were collected from 270 ground-squirrels. During the course of this survey many

Fig. 1. Richardson's ground-squirrel or common gopher, Citellus richardsoni.

Fig. 2. 1938 Travelling Laboratory and Equipment.

desiccated carcasses of ground-squirrels were found west of the Old Man Lake, but all of these were unfit for examination. One freshly dead ground-squirrel,(the body was still warm), was found on the northwest quarter of Section 33, Township 31, Range 10, West of the 4th Meridian, or just a quarter of a mile east of Old Man Lake. This ground-squirrel yielded two fleas, and on dissection showed inflamed glands and lung congestion (Fig.3). The fleas and tissue specimen were sent to the laboratory, and on examination both fleas and tissue specimen were found to be positive for Pasteurella pestis. This was the first record of plague in Canada.

The finding of plague-infected ground-squirrels in the Stanmore area aroused considerable interest, and it was decided that an attempt should be made to delimit, if possible, the area of infection, and that a ground-squirrel control campaign should be instituted in that area. Both of these measures were put into operation (See Ground-squirrel Control Campaign for details of operation), For the delimiting of the area of infection the investigating personnel was enlarged by the addition of two more men equipped with another travelling laboratory.

The main object of the 1940 investigation was to delimit, if possible, the area of plague infection, and to do this an intensive survey was made of a block of nine townships that were suspected to be the centre of plague infection. The time allowed for this work was not sufficient and only a little more than six townships had been surveyed when the ground-squirrels went into hibernation.

Fig. 3. First plague-infected ground-squirrel found in Canada, August 17,1939.

During the course of the survey 2,442 fleas and 71 tissue specimens were collected from 1,046 ground-squirrels. Of these, six collections were positive for plague.

It was determined that plague-infected ground-squirrels were present in an area measuring 9 miles east and west, and 5 miles north and south. The east boundary of this area was the Old Man Lake district (Fig.4). As a warning to the residents of the district that plague was present placards (Fig.5) were posted in the plague area, and also around the outer margin of the nine townships.

From information received and observations made during 1940 it was decided that the country east and south of the Stanmore district should be investigated in 1941; consequently the greater part of the work was carried on in that area. During the investigation 1,883 fleas and 144 tissue specimens were taken from 1,865 ground-squirrels. One tissue specimen, taken from a ground-squirrel found dead 14 miles south of Youngstown, was infected with Pasteurella pestis. This new plague area is 28 miles south of the Stanmore plague area (Fig.6).

At the end of the season this plague area was also placarded with warning signs.

Summary of the Investigation,1938-1941.

The following table summarizes the results obtained during the four year investigation.

Year.	Ground-squirrels.	Fleas.	Specimens.	Positives.
1938	821	2,025	1	--
1939	1,369	1,865	43	2
1940	1,302	3,556	81	6
1941	1,865	1,883	144	1
TOTALS	5,357	9,329	269	9

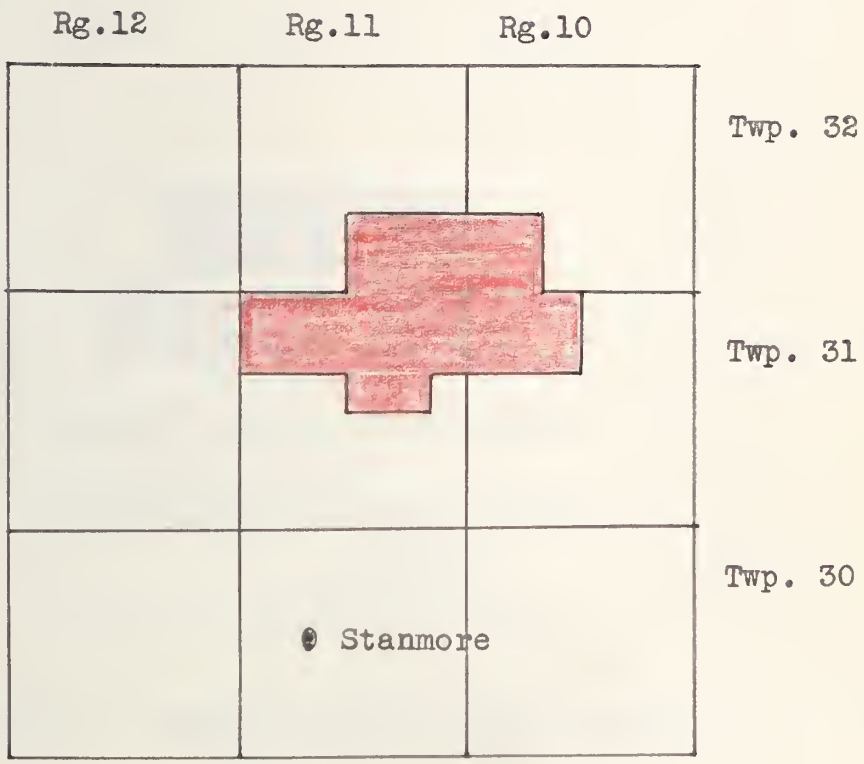
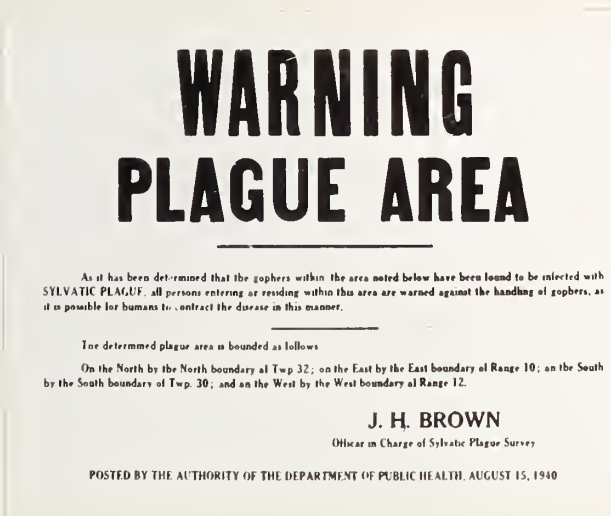


Fig. 4. Stanmore Plague Area in 1940.



WARNING
PLAGUE AREA

As it has been determined that the gophers within the area noted below have been found to be infected with SYLVATIC PLAGUE, all persons entering or residing within this area are warned against the handling of gophers, as it is possible for humans to contract the disease in this manner.

The determined plague area is bounded as follows

On the North by the North boundary of Twp 32; on the East by the East boundary of Range 10; on the South by the South boundary of Twp. 30; and on the West by the West boundary of Range 12.

J. H. BROWN
Officer in Charge of Sylvatic Plague Survey

POSTED BY THE AUTHORITY OF THE DEPARTMENT OF PUBLIC HEALTH, AUGUST 15, 1940

Fig. 5. Stanmore Plague Area Placard.

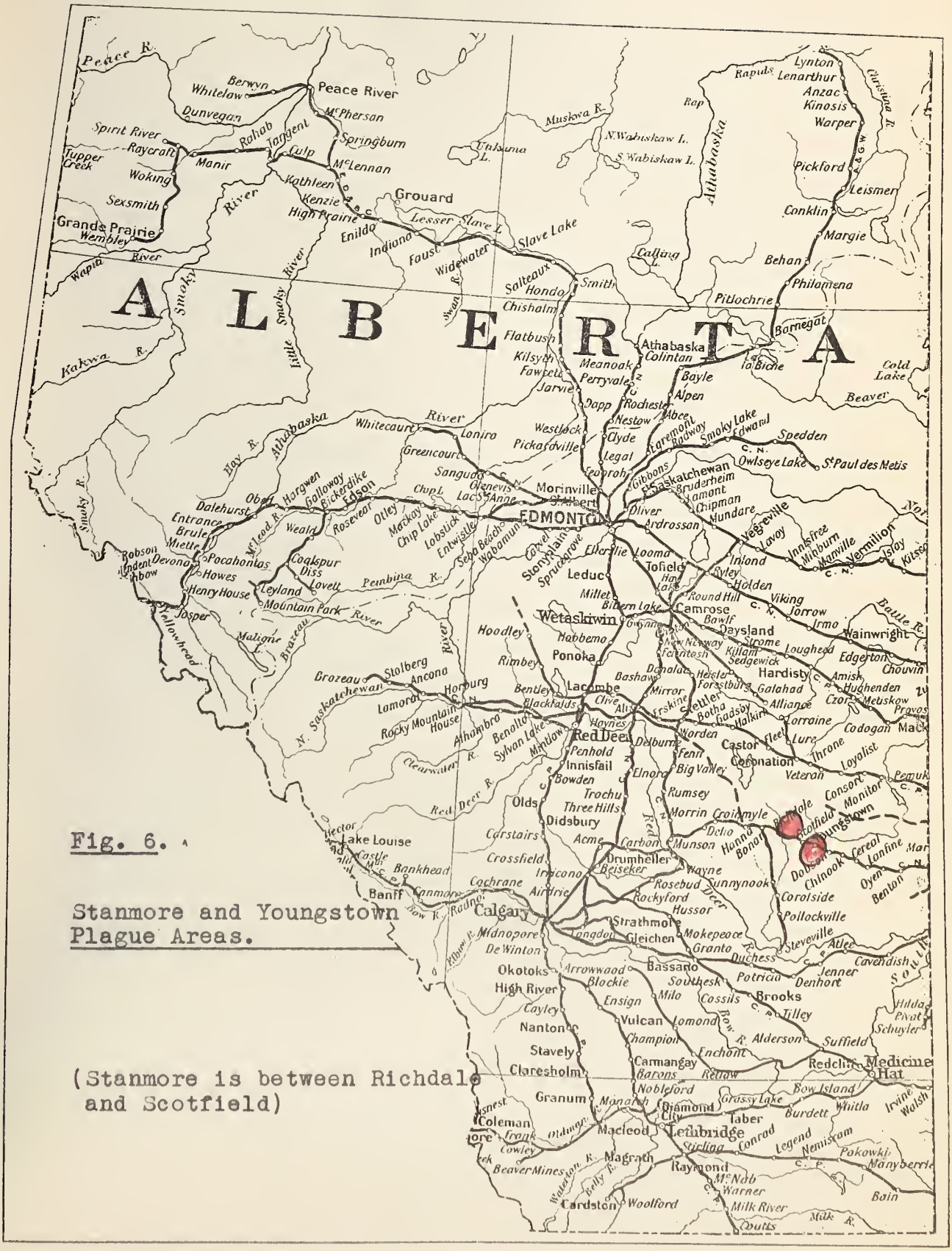


Fig. 6.

Stanmore and Youngstown Plague Areas.

(Stanmore is between Richdale and Scotfield)

T

Collecting Equipment.

When the investigation began in 1938 the travelling laboratory was modelled after those used in California, and consisted of a half-ton panel delivery truck with a built-in cabinet for holding the equipment, an auxiliary gasoline tank, and a water tank. Twelve-gauge shotguns were supplied for shooting the ground-squirrels.

During the course of the 1938 investigation it was found that Alberta conditions were vastly different from those existing in California, and that many changes were required in the arrangement of the travelling laboratory and equipment in order to achieve the best results. These changes, however, were not effected until 1940 when a second travelling laboratory was purchased. At that time both trucks were remodelled to suit Alberta conditions.

The collecting equipment as used in 1941 consisted of two travelling laboratories. One is a half-ton, and the other is a one-ton panel delivery truck. Both of these cars have built-in cabinets for the carrying of equipment and supplies, and each is provided with an auxiliary 25-gallon gasoline tank, and a 30-gallon water tank. Each car has a gun-case holding two .410 shotguns and a .22 rifle with telescope sights.

The standard equipment for each truck is as follows:-

1.	collaspable dissecting table.
1	de-mountable steel-top table.
2.	dissecting trays with spring clamps.
1.	" " " " " tray, plain.
2.	de-fleaing pans with covers.
1.	immersion pan.
1.	Coleman camp stove.
1.	" " " " " " " " " stand.
1.	hot-water sterilizer.
1.	flea-proof tin.
6.	Franklin boxes,(shipping boxes).
1.	garbage tin.
1.	pick, axe and shovel.
1.	dissecting box containing:-
	6 razor scalpels.
	6 packets razor blades.
	3 pairs pointed forceps.
	2 " " " plain forceps.
	1 pair bone cutters.
	1 de-fleaing knife.
	6 hand towels.
	6 pairs surgical gloves.
	6 " " " household gloves.
	4 rubber aprons.
	6 surgical masks.
	1 tin talcum powder.
12	boxes chloride of lime.
1	hand brush.
2	scrub brushes.
2	tins of formaldehyde.
10	pounds of chloroform.
24	rolls pf paper towels.
1	towel rack.
6	rolls of absorbent cotton.
1	tin of Snap.
1	tin of Flax Soap.
1	tin of Green Soap.
6	bottles of Alkorub.
1	quart of saline solution.
2	gross of small vials with corks.
8	dozen mailing tubes, assorted sizes.
8	dozen traps, assorted sizes.
500	12-pound paper bags.
150	16-pound paper bags.
2	shooting bags.
2	Cenco respirators.
1	First-aid kit.
8	dozen specimen jars.
	Ammunition, reporting cards, filing cases, maps, etc.

The Alberta Method of Surveying for Plague.

The method of surveying areas for the presence of plague as carried out in Alberta calls for a good knowledge of bacteriology, entomology and zoology, and a keen sense of observation. These qualities, coupled with good common sense, make the ideal combination for the survey work.

In carrying out a survey the investigating party moves into its designated area with the intention of shooting, defleaing and dissecting ground-squirrels, but first a reconnaissance survey is made of the area, usually six sections, by driving along the road allowances. This is done so that the ground-squirrel population can be noted, and it also gives the investigators an opportunity to select a suitable site for the dissecting. The number of ground-squirrels observed are marked on the township maps.

When the reconnaissance survey is completed the investigating party again covers the same territory, but this time they select and shoot ground-squirrels from each section. The shooting is done in the morning when the animals are the most active, and during the shooting each man wears a rubber glove on the left hand, and carries a supply of twelve-pound paper bags in his shooting bag. When a ground-squirrel is shot it is picked up with the glove-protected hand and placed in a paper bag; two animals are put in each bag. When the quota of 25 ground-squirrels has been shot, and the location of each animal marked on the paper bag, the investigators then move to the dissecting site. On arrival the bags are treated

with chloroform to kill the fleas. The dissecting equipment is then set up, and a large hole, to hold the remains of the dissected animals, is dug.

The dissecting table, when set up, holds the immersion pan, now three-quarters filled with a mixture of formaldehyde and water, and the two dissecting trays. The demountable table holds the dissecting kit and the specimen jars. The Coleman camp-stove is placed on its stand, pumped up and ignited, and the sterilizer, half-filled with water, is placed on it to boil. One set of instruments is placed in the sterilizer; this set is to be used for the removal of tissue specimens. Both investigators now don rubber gloves, rubber aprons and surgical masks. The purpose of the masks is to prevent the accidental rubbing of the contaminated gloves over the nose and mouth.

The member that is to do the defleaing (Fig.7) now spreads a sheet of paper towelling in the bottom of the de-fleaing pan. Then he opens a paper bag and removes a ground-squirrel. Holding the animal by the hind legs he scrapes it, in a downward motion, with the de-fleaing knife, paying particular attention to the tail, between the hind legs, and around the fore legs and neck. When he has completed the process the animal is placed in the immersion pan. (As de-fleaing is faster than the dissecting the pan soon contains a number of animals). When four or five animals have been de-fleaed, the fleas on the towelling are picked up on the end of a toothpick and placed in a vial of saline solution. An accurate count of the number of fleas is kept. All of the fleas from the one

collection of ground-squirrels are placed in the same vial and given the same serial number.

For the dissecting (Fig.7), the animal is spread-eagled on its back on the dissecting tray,--- the spring clamps being attached to each foot---, and the skin is laid back with four strokes of the scalpel. An examination of the exposed glands is made. Next the ribs are cut through, exposing the heart and lungs, and then the abdomen is opened, exposing the liver and spleen. A close examination is then made of these organs. If anything suspicious is found, such as enlarged or inflamed glands, adhered lungs, or abnormal liver and spleen, then specimens are taken. Tissue from the glands, liver and spleen is placed in a sterile specimen jar, and the heart and lungs are removed entire and placed in another sterile specimen jar. These two jars make one specimen and are marked with the same serial number. This serial number is the same as the serial number of the flea collection but it has the numeral "1" added, for example, flea collection 1-4-41 would have tissue specimen number 1-4-1-41.

Great care is taken during the dissecting that the investigators are not exposed, or do not expose themselves needlessly, to the danger of infection.

When the dissecting is completed all of the paper bags are burned, a large amount of chloride of lime is sprinkled over the discarded remains, which are then buried and the earth well trampled down. Then the utensils and instruments are thoroughly washed and scrubbed; the rubber gloves washed and dried. The used masks are placed in a glass jar for carrying

Fig. 7. De-fleaing and dissecting ground-squirrels, 1941.

back to the hotel where they are boiled at night.

After all of the equipment has been placed in the truck the investigators then give their hands and arms a thorough washing in an antiseptic soap solution.

Record cards (Figs. 8 & 9), in duplicate, giving the serial number of the collection, the number of animals shot, the location where shot, the number of fleas collected, the number of specimens taken, and the date and weather conditions are then made out and the original is sent with the collection to the laboratory at Kamloops, B.C. These cards are of vital importance as it is through them that every flea and tissue specimen can be traced back to its own particular area. Each card is signed by the senior member of the party.

The Method of Shipping Tissue Specimens.

The original method of shipping tissue specimens to the laboratory was by the use of one-gallon Thermos jars. This method was unsatisfactory as the jars would hold only two specimens, and the ice usually melted, leaving the specimen jars floating in the water. In 1939, with the aid of Mr. Franklin, a tinsmith in Hanna, a shipping box which is now known as a "Franklin Box" was devised. This box (Fig.10) consists of two boxes, one inside the other. The inner box holds the specimen jars packed in cotton, and the space between the inner and outer boxes is packed with ice. The inner box has a cover that can be sealed, while the outer box cover is hinged and fastened with a hasp. These boxes can be re-iced in transit without any danger of the specimens jars being broken.

FLEA SPECIMEN
RODENT PLAGUE SURVEY

ALBERTA

Spec. No. ..... Date ..... No. Vials ....

Location .....

No. Animals ..... No. Fleas .....

Species Animal .....

Tissue No. ..... Plague Area ..... Yes ..... No ..... Susp. .....

Remarks .....

.....

Inspector .....

Lab. Report:

Spec. No. .....

RODENT PLAGUE SURVEY

ALBERTA

Location ..... Date .....

Kind of Animal ..... No. in Bottle .....

ANIMAL No. (One to each column)	1	2	3	4	5	FOR LAB. USE
Fluid in Pleura						Date Rec.
Pneumonia						Condition
Subcutaneous Flush						
Enlarged Spleen						
Specks on Spleen						Date Tested
Specks on Liver						Exp. No.
Axillary Bubo						G.P. No.
Inguinal Bubo						Result:
Found Dead						
Shot						
No Lesions (For mass inoculation)						REMARKS:
Return Box to						
No. of Fleas ..... Label No. on Fleas						

Inspector .....

Epid. 7 1M-2-39

Fig. 8. Record Cards.

Epid. 8 5C-5-41

RODENT PLAGUE SURVEY

DAILY REPORT

ALBERTA

Stations.....Date.....

Details of Locality	Species of Rodent	S	T	F.D.	No. of Fleas	Flea Sample No.	Tissue Sample No.

REMARKS.....

Weather Conditions .....

Signature.....

.....

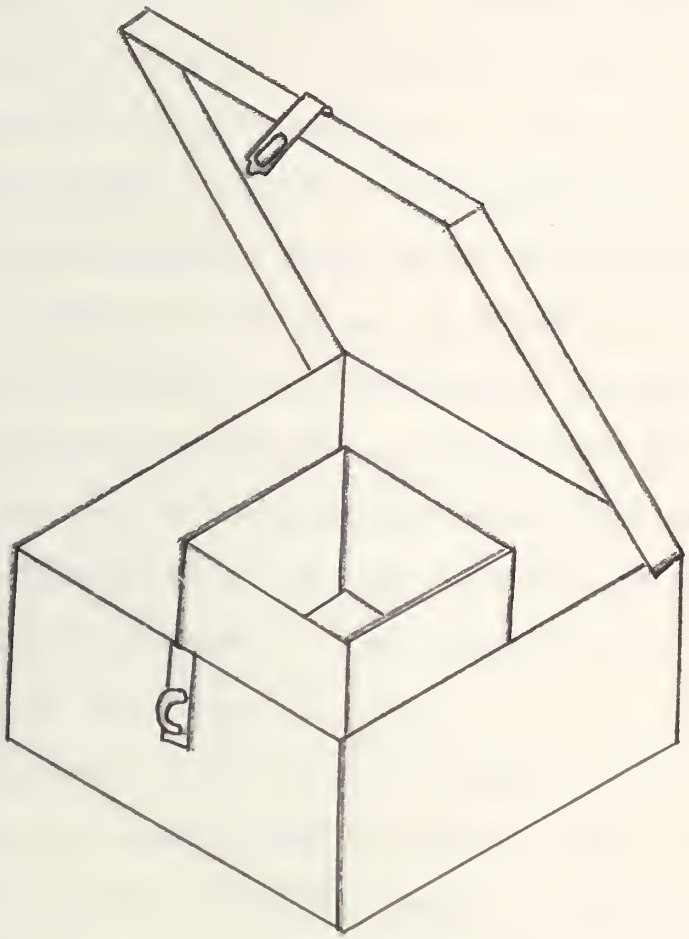
Fig. 9. Record Card.

These boxes, packed with ice, are taken to the field so that the tissue specimens, as soon as removed, are placed in a cool place.

Macroscopic Indications of Plague in Richardson's Ground-squirrel, (Citellus richardsoni).

During the four year investigation 5,357 ground-squirrels were dissected and examined macroscopically for indications of plague infection, but in no instance have the typical plague lesions, as produced in guinea pigs, been observed. The outstanding features of plague infection in Alberta ground-squirrels are as follows:-

1. Inflamed and sometimes slightly enlarged glands.
2. Marked emaciation.
3. Haemorrhagic condition in the intestine.
4. Lung adhesions.
5. Subcutaneous flush.



Dimensions:
Outer box:- 12 x 12 x 6 inches.
Inner box:- 6 x 6 x 6 inches.

Fig. 10. Franklin Box.

IX. GROUND-SQUIRREL CONTROL CAMPAIGN, 1940.

The discovery of plague-infected ground-squirrels in the Stanmore area during 1939 caused considerable concern, and it was decided that an attempt to prevent the spread of this disease should be made. Authorities state that plague infection in ground-squirrels spreads at the rate of 3 miles per year, and with this in mind it was decided that the purpose of the control campaign would be to check this spread. It was believed that by decreasing the numbers of ground-squirrels within the plague area the normal outward spread of the animals would be checked; in fact there was every reason to believe that this decrease would cause those ground-squirrels on the outside of the area to move into it and thereby concentrate the infection. The result of the campaign appears to confirm this view.

The organization of the control campaign began in November, 1939, and as no such campaign had ever been carried on in this province before it was necessary to gather much data, both by observation and correspondence, on the proper method of undertaking such a problem, and also on the most effective means of control. The cost of the control campaign was a big factor as the amount of money available for this purpose was very limited.

In organizing the campaign with the view of obtaining effectiveness and economy it was necessary that information be gathered on the following points:-

1. Approximate number of ground-squirrels in the area.

2. Whether poison gas or poison bait would be the more effecient control.

3. Number of men to be employed on the control crew.

4. The amount of land to be designated as the area in which the control would be conducted.

5. The method to be employed in carrying out the campaign.

1. Approximation of Number of Ground-squirrels.

The number of ground-squirrels per acre varies with different districts. Sanders (38) working in Saskatchewan found that there were approximately 25 burrows per acre. Brown (7) during two years investigation on plague in Alberta estimated that there were approximately 8 ground-squirrels per acre. Mr.K.H.Walker, Special Areas Fieldman, who investigated the ground-squirrel population at Stanmore, stated in a letter to the author that he estimated that there were 40 burrows per acre, and that on a basis of 10 burrows per animal this would give a population of 4 ground-squirrels per acre.

From the above information it was decided that an estimation of 5 ground-squirrels per acre would be a sound working basis, and the control was planned on that basis.

2. Poison Gas versus Poison Bait.

It was originally decided that "Cyanogas" would be used as the controlling agent as it would kill both the ground-squirrels and their fleas. Cyanogas has been used very successfully in various places and much information is available as to methods and amounts used. Sanders (38) recommended

that 2 ounces be placed in each burrow by using a long-handled spoon. Wade (50) recommended the same method. The State College of Washington (51) recommends using a dusting machine and Cyanogas dust. Tillyard (48) in New Zealand, and workers in South Africa (39) also recommended the dust and dusting machine.

Taking the rate of 2 ounces per burrow as being the most effective, and considering that there were 40 burrows per acre, it would mean that 5 pounds of Cyanogas would be required for each acre, or a total of 3,200 pounds per section. As at least two Townships (72 sections) were to be classified as the control area, it was obvious that the use of Cyanogas was beyond consideration when calculated on the basis of 60 cents per pound for the chemical. Another important fact was that by using Cyanogas dust and a dusting machine one man could only treat a maximum of 8 acres per day.

In view of the above information it was decided to abandon the use of poison gas and seek an effective poison bait. The bait decided upon was one that had been used by the Field Crops Branch, Alberta Department of Agriculture, and had met with considerable success. This bait consisted of a mixture of sodium arsenite and oats in the following proportions:-

Sodium arsenite---------- ¾ Gal.
Oats---------- 1 Bushel.
Water---------- 1 to 1½ Gallons.

Dilute the sodium arsenite with water; pour the solution over the oats, and mix in a mechanical mixer. Mix thoroughly and allow to soak for 12 to 24 hours before using.

This bait was very cheap to manufacture and was also easy to handle.

The use of this bait as a control was decided upon with

the full knowledge that it would kill only the ground-squirrels and not their fleas. This was, of course, potentially dangerous as it might cause the fleas, after they had been deprived of their natural hosts, to transfer to man, but under the financial circumstances it was the only method of control that could be operated effectively in the plague area.

3. Number of Men on the Control Crew.

With the amount of money available for this work still a limiting factor, it was decided that a total of 15 men would be the most efficient number (Fig.11). These were divided up on the following basis:-

One man as foreman in charge.

Two men, a truck-driver and an assistant, to keep the crew supplied with poison bait, and to mark out with flags the territory to be covered by each man.

Twelve men to spread bait.

4. The Control Area.

The designated control area is shown in Figure 12 and consists of 73 sections, or a total of 46,720 acres, in the Stanmore area. This area includes the 1939 plague area, and all that land deemed to harbour plague-infected ground-squirrels.

5. Method of Spreading Bait.

In spreading the bait a "basic unit" system was used. A basic unit consisted of an area of land one mile wide and two miles long, which is the equivalent of two sections.

Fig. 11. Control Campaign Crew, 1940.

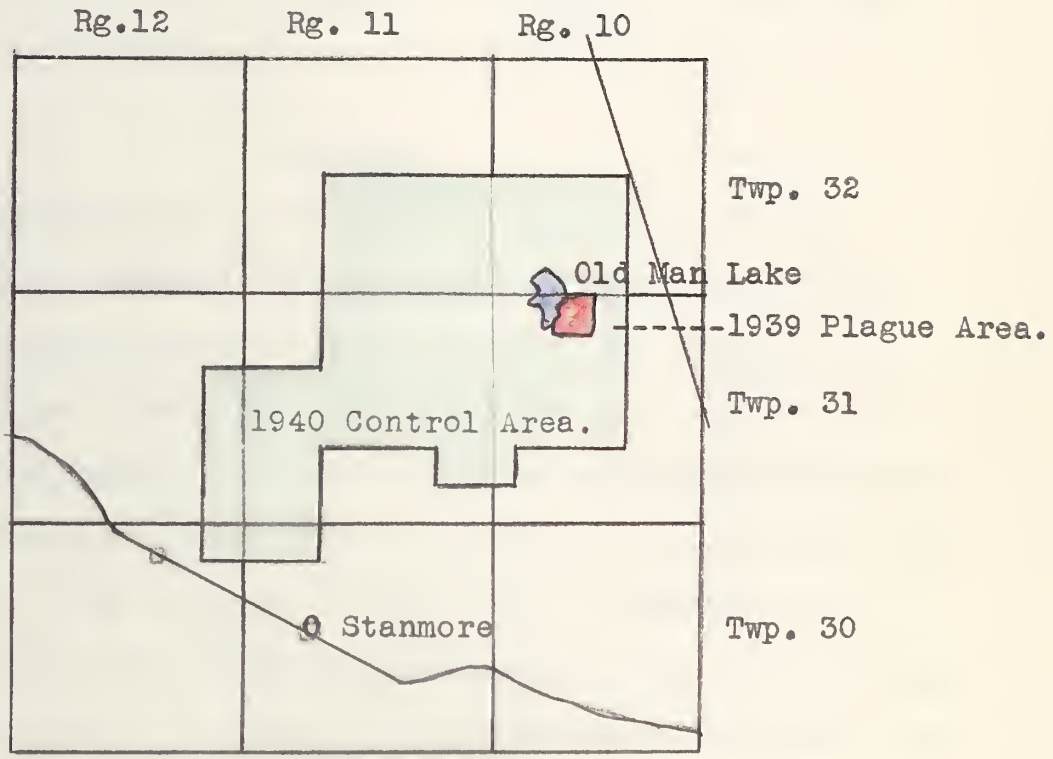


Fig. 12. 1939 Plague Area and 1940 Control Area.

The treating of a basic unit was considered as a day's work.

To spread the bait the men were lined up on the mile width of the unit, and each man was allotted an area one-twelfth of a mile wide and two miles long as his territory; this was marked out by the use of flags at half-mile intervals. Each man carried a pail of bait,and a long-handled spoon for placing the bait at the entrance of the burrow. The bait pails were replenished at intervals from the supply carried in the truck.

Results.

As a general rule poison bait is best early in the spring before any green vegetation is present,for at such times the ground-squirrels find the bait very attractive. Later on in the season the common run of bait mixtures lose their attractiveness, but it is apparent the sodium arsenite and oats bait was able to prove attractive up until the middle of June. The ability of this bait to compete with the green vegetation in attracting ground-squirrels is in a large measure responsible for the gratifying results obtained, for it must be remembered that the campaign did not get under way until the second week in May and that it continued for six weeks.

The control area was checked over twice during 1940,and once during 1941, and it is estimated that between a 60 and 75 percent kill of ground-squirrels was obtained. At first glance this does not seem to be a very good kill, but when it is understood that this kill was obtained during the time when

green vegetation was plentiful it is realized that it is in reality a very exceptional accomplishment.

When the campaign was organized plans were made for the setting to one side of certain definite areas on which the effectiveness of the bait could be determined, but the lack of funds prevented this from being carried out.

X. SIPHONAPTERA (FLEAS).

Description.

This order, which is large and complex, is still in the process of being arranged taxonomically; there is therefore considerable variation in the nomenclature of families, genera and species.

Fox (16) defines fleas as being insects that are :- "Wingless; the body laterally compressed. Mouthparts formed for piercing and sucking. Antennae three-jointed and situated in a groove. Eyes simple, sometimes vestigial or absent. Tarsi five-jointed; the coxae well-developed. Metamorphosis complete."

All fleas are ectoparasites on warm-blooded animals and birds and are also found in their sleeping quarters and nests.

Life-History.

The fed and fertilized adult female lays her eggs in the nest or sleeping quarters of the host. The eggs hatch, varying with the species and climatic conditions, in 4 to 15 days into slender, legless, worm-like creatures that have chewing mouthparts. These are the larvae, and they feed on the organic material in the dust of the nest, the blood in the excreta of the adults being an important source of food. In from one to four weeks the larva moults three times and enters the pupal stage where it remains for one to four weeks and emerges as an adult.

The adults frequent the body of their host for the purpose of feeding on blood. Both sexes feed very readily. Copulation usually takes place on the host.

Fleas are usually specific in their selection of host; that is, each animal or bird has its own particular species, but if necessary they will take blood from any available host. It is not definitely known if all species require the blood of their specific host in order to reproduce.

Importance.

Fleas are of importance because certain species transmit the dreaded bubonic plague, while other species infest homes and annoy man and his domestic pets.

The finding of plague in Alberta in 1939, and the knowledge that plague can be transmitted by fleas, has aroused considerable interest in the fleas of Alberta. During the four year investigation already discussed fleas were collected from a wide range of animals in order that some knowledge of the species present could be obtained.

It was determined that four species of fleas that could transmit plague were present in the province, the most interesting occurrence being the recovery of a human flea, Pulex irritans Linn., from a badger in the Stanmore plague area. Matheson (34) states that this species can act as a plague vector during outbreaks.

Fleas of Alberta.

Considerable time has been spent on the collecting and determining of fleas, and Brown (8) lists 3 families, 13 genera, and 15 species known to occur in Alberta. They are listed, with notes on host and locality, as follows:-

PULICIDAE.

Pulex irritans Linn.*

1, Vega, in house; 1, Dewberry, on child.
1, Stanmore, badger.

Cediopsylla inaequalis Baker.
2, Orion, jackrabbit.

Ctenocephalides canis Curt.
3, Edmonton, dog.

Ctenocephalides felis Bouche.
8, Edmonton, cat.

DOLICHOPSYLLIDAE.

Foxella igbotus albertensis Baker.
2, Waterton, pocket-gopher.

Opisocrostis labis J & R.*
3, Stanmore, ground-squirrel.

Opisocrostis tuberculatus Baker.
1, Edmonton, not recorded.
6, Stanmore, ground-squirrel.

Oropsylla rupestris Jordan.*
4, Lethbridge, ground-squirrel.
2, Stanmore, ground-squirrel.

Orchopeas species. *
4, Waterton, red pine-squirrel.

Megabothris vison Baker.
1, Waterton, chipmunk.
2, Waterton, red pine-squirrel.

Megabothris wagneri Baker.
1, Waterton, white-footed deer-mouse.

CERATOPHYLLUS COMPLEX.

Thrassis petiolatus.
3, Waterton, Columbia ground-squirrel.

HYSTRICHOPSYLLIDAE.

Hystrichopsylla dippiei Roths.
2, Stanmore, Richardson's ground-squirrel.

Epitedia species.
2, Stanmore, Richardson's ground-squirrel.

Tamiophila species.
1, Stanmore, Richardson's ground-squirrel.

Neopsylla inopina Roths.
1, Waterton, Columbia ground-squirrel.

Those species marked with an asterisk are known plague vectors.

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